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Bomb radiocarbon dating and estimated longevity of Giant Sea Bass (*Stereolepis gigas*)

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Abstract.—In January 2010, a massive giant sea bass (500 lbs, 227 kg; near maximum reported size of 557 lbs, 253 kg) was captured off Santa Cruz Island by commercial gill-netters. This specimen presented a unique opportunity to estimate and validate of the potential longevity of the largest nearshore teleost of the northeastern Pacific. A transverse section of the sagittal otolith produced consistent counts of 62 opaque annuli along two different axes of the ventral sulcus region, translating into an estimated birth year of 1948. This age estimate was supported by measurements of radiocarbon (^{14}C) in the other sagittal otolith core (within the first year of growth), relative to $\Delta^{14}C$ reference records used for bomb radiocarbon dating. Two otolith core samples produced $\Delta^{14}C$ values that were classified as pre-bomb (prior to ~1958–59), indicating a minimum lifespan of 51 years. It is likely that giant sea bass can live more than 60 or 70 years based on growth zone counts, but there is no evidence in the literature or this study to support longevity of 100 years.

Introduction

The Giant sea bass (*Stereolepis gigas*) is the largest nearshore teleost inhabiting coastal waters of Southern California and Baja California, Mexico, yet much of its life history is not well know (Miller and Lea 1976). The species is a grouper-like member of the wreckfish family (Polyprionidae; Shane et al. 1996) and occur from Humboldt Bay in northern California, south along the west coast of North America to the tip of Baja California, and into the Gulf of California (Eschmeyer et al. 1983). It rarely occurs north of Point Conception and was once common in the Southern California Bight (SCB; Crooke 1992). Giant sea bass are apex predators and represent the only resident fish "megacarnivore" in the California kelp bed community (Horn and Ferry-Graham 2006). It has been an important target of commercial and recreational fishing since the late 1800s (Figure 1) and attains a maximum reported length of 7′ 5″ (2.26 m TL) and a weight of 557 pounds (253 kg; Fitch and Lavenberg 1971, Eschmeyer et al. 1983). Commercial fishing of giant sea bass began in California waters, but shifted south of the US border as the population numbers in the SCB declined after 1936 when massive fish became rare in catches (Crooke 1992). The lack of life history information for giant sea bass is likely a result of the practice of dressing-out (beheading and eviscerating) fish prior to landing to conserve space on fishing vessels (Crooke 1992). This practice is unfortunate for scientists because, in addition to losing data on actual fish size, the lost head and entrails contain the structures most useful in life history studies – gonads for size-at-maturity estimation and (key to this study) otoliths for studying age and growth.

Fig. 1. A world record (428 pound) giant sea bass (*Stereolepis gigas*) caught by John T. Perkins off Catalina Island, CA in June 1905 in the years prior to the fishery collapse for this apex predator off California in 1936.

Despite its importance as a fishery and its huge size, the estimated lifespan of this species has not been rigorously evaluated.

In response to greatly depressed population levels, legislation was enacted to protect the fishery. In 1982 the California State Legislature banned the commercial fishing of giant sea bass in California waters, with the caveat of allowing commercial gill-netters to take one giant sea bass per trip. In addition, the California Fish and Game Commission banned recreational landings from California in 1982, while allowing anglers to capture two fish per trip from Mexican waters on long-range expeditions from California (Crooke 1992). In 1994, restrictions on gill and trammel netting increased protection for the species by banning this kind of fishing in state waters (within 3 miles of the mainland and 1 mile of the islands) in the SCB (California State Proposition 132). This proposition, known as The Marine Resources Protection Act, also implemented fishing depth restrictions off several mainland counties and around the Channel Islands. Most recently,

concerns over sustained population viability led to the International Union for Conservation of Nature (IUCN) red listing the giant sea bass as a "Critically Endangered" species (Musick et al. 2000, Cornish 2004). The measures taken to protect this species appear to have been effective because the number of juvenile giant sea bass being reported as caught and released is increasing (Baldwin and Keiser 2008), and it is one of the five species of large near shore predators reported as returning to the SCB (Pondella and Allen 2008).

Much of the biological information available for giant sea bass is contained in the writings of the late California Fish and Game biologist, John E. Fitch (1918–1982). While much of the age and growth information is unique, the details of how these estimates were derived are either lacking or not thoroughly described. The oldest age estimated using otoliths is 72 to 75 years for a giant sea bass weighing 435 pounds (197 kg; Fitch 1965). In contrast, a larger fish, a beached 7-foot specimen weighing 539 pounds (244 kg) from San Clemente in 1963, was reported to be about 60 years old based on otolith ring counts (Fitch 1965). In addition, an estimate of approximately 50 years was provided for a medium sized fish (320 lb; 145 kg) with no derivation details (Fitch and Lavenberg 1971). The language from these sources, and the methods in use at the time, imply that surface reading of whole otoliths was used to estimate age. This perception was confirmed, coupled with the use of otolith clearing agents, by a researcher familiar with the laboratory practices of these researchers at the time (G.M. Cailliet, Moss Landing Marine Laboratories, personal communication). A longevity estimate of 90 to 100 years has been uncritically listed in some sources of life history information (e.g. Shanks and Eckert 2005). The origin of this estimate is speculatively based on a 557 pound (253 kg) fish caught in 1962, even though and it was clearly stated that there is "no reliable information to support such a theory" (Fitch and Lavenberg 1971). To date, there are no validated age data to support any conclusions about the longevity of this species.

There are few other data on growth and estimates of age at maturity in giant sea bass. Early age and growth is reported as 7 inches at age 1 year and twice this length at age 2 years (Fitch and Lavenberg 1971). Fitch and Lavenberg (1971) also mention an estimated age of 11 to 13 years at sexual maturity. This is similar to a reported age-at-maturity of 11 years for all giant sea bass, but there is a conflict from the observation by Domeier (2001) that "most fish" were mature at 7 to 8 years. In addition, age estimates reported for small to medium sized fish are 6 years at 30 pounds (14 kg), 10 years at 100 pounds (45 kg), and 15 years at 150 pounds (68 kg), but details of the age estimation method were not provided (Domeier 2001). A complete ageing study of giant sea bass at this time is unlikely due to their depressed population numbers and protected status, but questions of longevity can be answered with the application of bomb radiocarbon dating, a unique tool in estimating valid fish age.

Because age validation can be difficult for deepwater and long-lived fishes, bomb radiocarbon dating has evolved as a unique application aimed at addressing these issues (Campana 2001). The approach relies on a conserved record of the rapid increase in radiocarbon that occurred in the oceans of the world as a result of atmospheric testing of thermonuclear devices in the 1950s and 1960s (Broecker and Peng 1982). The uptake of bomb-produced radiocarbon by the marine environment, reported as delta carbon-14 ($\Delta^{14}C$) with reference to an established pre-nuclear radiocarbon record (Stuiver and Polach 1977), was virtually synchronous in the mixed layer of mid-latitude oceans and this signal was first recorded from marine carbonates in hermatypic corals (Druffel and Linick 1978). This time-specific signal provides a reference period that can be used to

determine age. The application of bomb radiocarbon dating to fishes began with an innovative comparison of $\Delta^{14}C$ values recorded in otolith carbonate (core material) relative to regional $\Delta^{14}C$ records from hermatypic corals of the Great Barrier Reef (Kalish 1993). In this and other studies, measured $\Delta^{14}C$ levels provided an independent determination of age for validation of age estimates from growth zone counting in otoliths (Campana 1997; Kalish et al. 2001, Piner and Wischiowski 2004). Bomb radiocarbon dating has since been applied successfully to the otoliths of many species of teleost fishes, some of which are deep-water species with larval or juvenile phases in the mixed-layer, to validate estimated age (e.g. Andrews et al. 2007; Ewing et al. 2007; Neilson and Campana 2008). Of paramount importance for a successful application of bomb radiocarbon dating is the assembly of a suitable $\Delta^{14}C$ reference chronology from the region.

The goals of this study were to estimate the age of a massive giant sea bass specimen based on visual counts of growth zones in a thin-sectioned otolith and to validate this age estimate with bomb radiocarbon dating. It was hypothesized that a transverse otolith section would reveal growth zones (annuli) whose counts would represent putative age in years. To provide a validation of the age estimate, it was further hypothesized that bomb radiocarbon dating could be performed by: 1) assembling a regional $\Delta^{14}C$ reference chronology; and 2) measuring $\Delta^{14}C$ in the otolith core (within the first year of growth) would provide an independent estimate of age. Because the specimen used for the study was near maximum size, we assert that the findings of this study provide a minimum estimate of the longevity of giant sea bass.

Methods

Specimens and size

In January 2010, a near maximum size giant sea bass (500 pound or 227 kg was captured off Santa Cruz Island by commercial gill-netters legally targeting white seabass (*Atractoscion nobilis*). The giant sea bass was landed legally at Santa Barbara as incidental bycatch (one allowed per trip). Brian Colgate, the owner and manager of the Santa Barbara Fish Market, notified the senior author (with assistance from commercial fisherman Gary Burke) of the landing and made both the head and landing photograph of this large specimen available for scientific study. The head (57 cm in length) was transported to the Nearshore Marine Fish Research Program (NMFRP) laboratory at California State University Northridge for further study. In the laboratory, various morphometric measurements of the head including head length (HL) were recorded and both sagittal otoliths were extracted for use in ageing (left sagitta) and bomb radiocarbon analysis (right sagitta). Total length (TL) of the large specimen was estimated using the proportion of HL to TL based on a lateral view photograph of the specimen (Figure 2). The dressed weight (420 pounds or 191 kg minus viscera and gills) at landing was converted to round (undressed, whole) weight of 496 lbs (rounded to 500 lbs) using the equation, round weight = (1.15·dressed weight) − 0.46, calculated for large Atlantic wreckfish (*Polyprion americanus*) (Sedberry et 23 al. 1994).

A single small (145 mm TL) giant sea bass was collected on June 10, 2008, off Seal Beach, California, during a white seabass gill net survey conducted for the Ocean Resource and Hatchery Program (OREHP) of the California Department of Fish and Game (Allen et al. 2007). This specimen, known to be 1-year-old based on length change observations previously noted, was used to compare growth ring structure in the otolith

Fig. 2. A near maximum size (7 ft; 500 pound) giant sea bass (*Stereolepis gigas*) captured by an anonymous commercial fisherman (pictured) in January 2010 off Santa Cruz Island and legally landed at the wharf in Santa Barbara (photo courtesy of Jeffrey Cecilia, Santa Barbara Fish Market).

sections and to provide a reference for first-year growth within the core of the sagitta from the massive specimen (identify location of the first annulus).

Age estimation

Sagittal otoliths were removed using the method of Craig et al. (1999). In order to access the otoliths, the gill arches and flesh covering the parasphenoid bones were first removed. A hacksaw was used to cut through the basioccipital and parasphenoid bones, stopping at the capsular otic bulla, the chamber containing the semicircular canals and otoliths. Extracted otoliths were cleaned with freshwater and stored dry.

The left sagitta of each specimen (n = 2) were mounted on a wood block with cyanoacrylate adhesive for transverse sectioning. A 0.5 mm section through the focus was taken using a Buehler-IsoMet® double bladed, low speed saw with diamond edged blades separated by a stainless steel shim (Allen et al. 1995). Sections were removed from the blocks and polished using silicon carbide lapping paper on a lapidary wheel. Each section

was placed in a black-bottomed watch glass filled with water and digitally imaged at 50× magnification under a Wild dissecting scope. Three separate images for the large specimen were merged into one composite image using Calico Panorama software (www.kekus.com). Annuli were counted directly from the digital images of these sections. Each section was read twice by both authors after initial full otolith section examinations and a collaboration on the interpretation of the innermost growth, based on early growth observations (i.e. Walford 1937; Fitch and Lavenberg 1971) and extrapolation of early growth rates (Shane et al. 1996).

Radiocarbon analysis

The whole otolith of the massive specimen was mounted on a glass slide with the sulcus side down, making the distal surface accessible for core extraction by micromilling. Cytoseal® was used as an adhesive and was allowed to cure for several days prior to further preparation. Because the adult otolith accreted a significant amount of otolith material onto the distal side of the otolith, hand grinding with 320- to 1000-grit wet-dry sandpaper (silicon-carbide) in water was necessary to expose the earliest otolith growth. The first few years of growth were clearly visible as grinding proceeded and the concentric growth zone structure was used as a guide in exposing the core. Milling was an extraction of the smallest core structure visible, which was defined as a small, crenulated otolith-core outline. This part of the otolith was more opaque than the more recently formed otolith growth layers and was used as a template for extraction with the micromilling bit.

Core material was extracted from the otolith using the computer automated capabilities of a New Wave Research® (ESI–NWR Division; Fremont CA 94538 USA) micromilling machine. A 0.5 mm diameter Brassler® (Savannah, GA 31419 USA) bit was used to drill an overlapping surface extraction within the oval dimensions of 6.0 mm long by 3.5 mm wide. The computer was used to guide the surface extraction over the uneven surface structure of the otolith (uneven from hand grinding and mount angle). A depth of 350 μm was extracted with two passes of the scan at 175 μm each. These dimensions were within the 1-year-old otolith dimensions of the smaller fish discussed previously and available material was sufficient to extract two separate samples from the otolith core. Both samples were submitted to the National Ocean Sciences Accelerator Mass Spectrometry Facility (NOSAMS) at the Woods Hole Oceanographic Institution (WHOI) in Woods Hole, Massachusetts, for routine radiocarbon analyses.

Radiocarbon measurements were reported from NOSAMS as the Fraction Modern (Fm), which was used to calculate $\Delta^{14}C$ with a correction for natural isotopic fractionation. Fraction Modern is the measured deviation of the $^{14}C/^{12}C$ ratio from a "modern" sample, which is corrected for fractionation using a within-instrument $\delta^{13}C$ value for each sample. The calculated $\Delta^{14}C$ values reported in this study were also corrected for estimated age based on growth zone counts for an approximate time of formation and a calculated birth year (Stuiver and Polach 1977).

Regional $\Delta^{14}C$ reference chronology

Regional reference records from the northeastern Pacific Ocean were gathered to provide an age calibration source for the measured $\Delta^{14}C$ values from the otolith core of the massive specimen. Records of $\Delta^{14}C$ for the critical period, from pre-bomb to the rise in $\Delta^{14}C$ (after 1958–1959), were selected based on previous use in other studies and some regional similarities in timing and magnitude. Potential discrepancies and pitfalls were considered and described relative to the measured otolith $\Delta^{14}C$ values and conclusions of

age. Pre-bomb $\Delta^{14}C$ values provided by the reference $\Delta^{14}C$ records were used to derive a mean $\Delta^{14}C$ value and a 2 SD upper limit for the pre-bomb period (Kerr et al. 2004). This upper limit was used to define pre-bomb *versus* post-bomb $\Delta^{14}C$ values measured in the core material from the massive specimen.

Bomb radiocarbon dating

Age was estimated based on the otolith $\Delta^{14}C$ values relative to the time for regional $\Delta^{14}C$ reference values were in agreement. The correlation between the otolith $\Delta^{14}C$ value and the regional $\Delta^{14}C$ reference records were initially attributed to a general region of the reference curve (pre-bomb, bomb rise, peak, or post-bomb decline; Andrews et al. 2011). A birth year, calculated based on the estimated age by growth zone counts, provided a temporal comparison. For pre-bomb levels, a minimum birth year and age was estimated based on the last year the level was measured, plus a nominal uncertainty of a few years based on the variations in the rise of $\Delta^{14}C$ as estimated by the 95% CI from the yelloweye rockfish $\Delta^{14}C$ record.

Results

Specimens and size

The head length (HL) of our large specimen was 57 cm. Based on the photograph of this specimen (Figure 2), this HL equates to a total length of 2.2 m (7 ft). The dressed weight (420 pounds or 191 kg minus viscera and gills) at landing corresponds to an estimated round weight of approximately 496 pounds (± 12 pounds). We therefore round up to 500 pounds (227 kg) for reporting purposes. From these data, we conclude that this specimen was approaching maximum known size for this species.

Age estimation

The right sagitta of the large specimen was extracted unbroken and measured 36.1 mm in length by 11.7 mm in width (max) and weighed 2.26 g (Figure 3). The rostrum of the left sagitta of the large individual was broken during extraction and is not pictured. The section from the single left sagitta of the small specimen (145 mm TL) was estimated to be 1-year-old based on length frequency observations previously discussed, which was supported by the presence of a single, well developed growth ring at the margin of the sectioned otolith (Figure 4). Using the width of this otolith as a reference starting point, the section of the massive specimen's sagitta yielded consistent counts of 62 rings along two axes of the ventral sulcus region (Figure 5). Based on growth zone counts age was estimated as 62 years old at capture, with a birth year of 1948.

Radiocarbon analysis

Two samples were successfully extracted from the otolith core of the massive *S. gigas* specimen (Table 1). The mass of these samples was low, but measureable by AMS; radiocarbon measurements are reported as Fraction modern (Fm), with calculated $\Delta^{14}C$ values. Each of the $\Delta^{14}C$ values is consistent with each other within the margin of instrument error.

Regional $\Delta^{14}C$ reference chronology

The regional $\Delta^{14}C$ reference records selected from the northeastern Pacific Ocean are a combination of otolith, invertebrate, and dissolved inorganic carbon (DIC) sources from both local and distant locations (Figure 6). The more distant $\Delta^{14}C$ reference records are

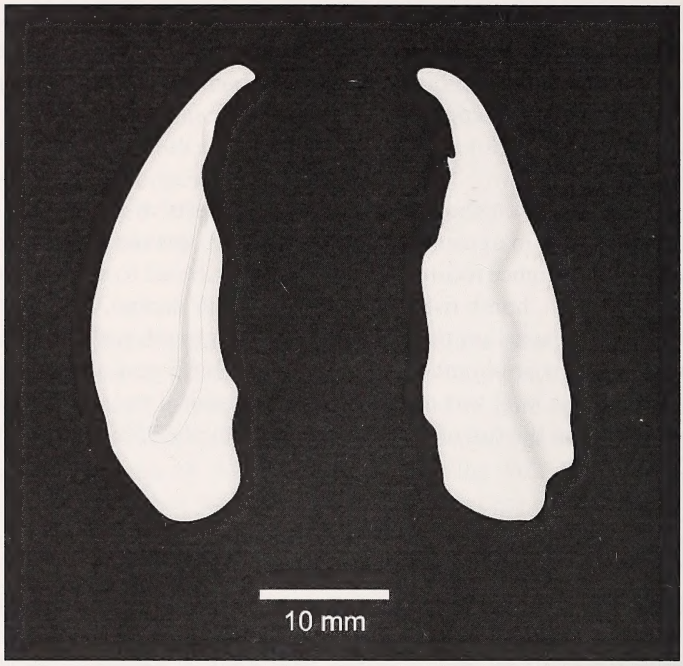

Fig. 3. Medial (left), and distal (right) view of the right sagitta from the 7 ft, 500 pound giant sea bass (*Stereolepis gigas*) captured in January 2010 off Santa Cruz Island, California. © Larry G. Allen.

from the Gulf of Alaska (GOA): 1) yelloweye rockfish (*Sebastes ruberrimus*; Kerr et al. 2004); and 2) Pacific halibut (*Hippoglossus stenolepis*; Piner and Wischniowski 2004). These records, despite their distance from the SCB, are necessary for the comparison because they are the nearest comprehensive $\Delta^{14}C$ records that provide an indication of when the rise in $\Delta^{14}C$ occurred for the northeastern Pacific Ocean. Each provides measured $\Delta^{14}C$ values from the pre-bomb to post-bomb and a basis for the approximation of a rise time for $\Delta^{14}C$ in the SBC. Reference $\Delta^{14}C$ records and values from the SCB are from known-collection-year white abalone shells (*Haliotis sorenseni*; A.H. Andrews, unpublished data) and estimated-age cowcod rockfish (*Sebastes levis*; Andrews, unpublished data). Known age and estimated age material from all of these sources were used to provide a baseline mean value for pre-bomb $\Delta^{14}C$ levels, as well as a few post-bomb $\Delta^{14}C$ references, in the SCB. Measurements of $\Delta^{14}C$ from samples with estimated age were chosen as a reference because once pre-bomb $\Delta^{14}C$ levels are reached the time-specificity of the measurement is restricted to a minimum age value is irrelevant. The pre-bomb reference for $\Delta^{14}C$ levels for white abalone and cowcod were previously established based on the increase in $\Delta^{14}C$ from other measurements (A.H. Andrews, unpublished data). Mean pre-bomb $\Delta^{14}C$ within the SCB was $-85.0‰$ ($\pm$ 6.9 SD) with an upper limit (2 SD) of $-71.2‰$ as the criterion for measured $\Delta^{14}C$ levels that would be considered post-bomb when exceeded. Specific to this study, we used this value to define pre-bomb *versus* post-bomb $\Delta^{14}C$ values measured in the giant sea bass otolith core material.

In support of the 2 SD criterion for pre-bomb designation, $\Delta^{14}C$ values measured in DIC from various locations were gathered to document the regional rise of $\Delta^{14}C$ and the variability of post-bomb levels. A record from Scripps Pier provided a first rise of $\Delta^{14}C$

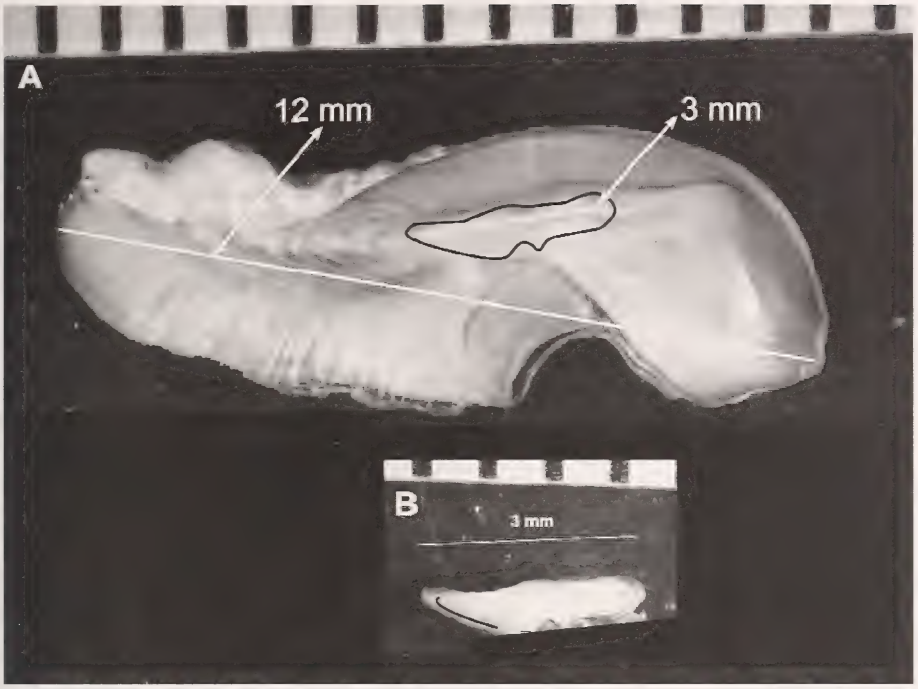

Fig. 4. Thin, transverse cross-section of the left sagitta from the massive specimen of giant sea bass (A), with a transverse section of the left sagitta from a 145 mm TL, 1-year-old (B) giant sea bass (first year growth ring indicated by black line). The dorso-ventral height of the otolith in cross-section from the massive fish was 12 mm and the 1-year-old was 3 mm. The outline of 'B' section was superimposed on to 'A' section to delineate where the first ring was identified for age estimation of the large specimen. All rings proximal to the core were considered as sub-annual structures within the first year of growth.

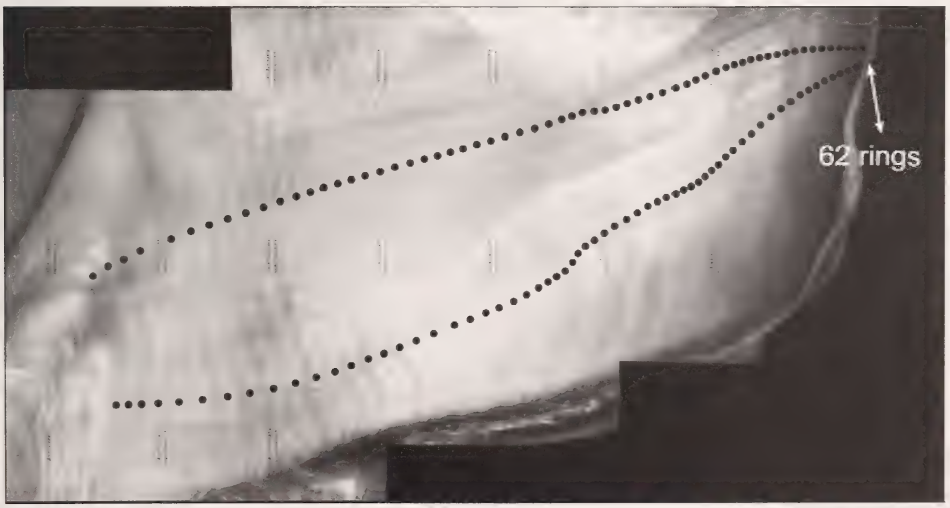

Fig. 5. Transverse otolith (left sagitta) section (0.5 mm thick), observed with reflected light (50×), from the massive giant sea bass captured in January 2010 off Santa Barbara, CA. Counts of 62 opaque annual bands (black dots) along two axes of the ventral sulcus region.

Table 1. Sample data for extractions made from the otolith core of the massive *S. gigas* specimen. Because the measured $\Delta^{14}C$ values were classified as pre-bomb, only a minimum age can be determined from the last year these values were recorded in the reference series (Figure 6). Minimum birth year and age from were based on the rise time common among $\Delta^{14}C$ references (~1958–59). Samples were processed in 2011 and corrected to the estimated date of formation (1948). Correction for fractionation with measured $\delta^{13}C$ was made on-line (during sample processing) by the AMS and is not recorded in the output.

Sample number	NOSAMS number	Sample weight (mg)	Fraction modern	$\Delta^{14}C$ (‰)	$\Delta^{14}C$ birth year & age	Growth zone birth year & age
GSB 2010A	OS-86916	0.9	0.9214 ± 0.0036	−78.4 ± 3.6	Pre-1959 (>51 yr)	1948 (62 yr)
GSB 2010B	OS-86917	1.7	0.9229 ± 0.0036	−76.9 ± 3.6	Pre-1959 (>51 yr)	1948 (62 yr)

for August 1959 (mean = −53‰), with two post-bomb values increasing in concert with the $\Delta^{14}C$ slope from GOA to a maximum of 138‰ in 1969 (Linick 1978). Post-peak $\Delta^{14}C$ values for DIC revealed a moderate decline for winter conditions (outside the period of upwelling) from two data points, one in October 1980 (109‰) and the other in 1987 (92‰; Druffel and Williams 1991, Williams et al. 1991). A seasonally comprehensive $\Delta^{14}C$ record, covering the period of upwelling, indicated that changes in $\Delta^{14}C$ within a year could be on the order of 100‰ in the post-bomb period (Robinson 1981). This level of seasonal signal attenuation is similar to the findings for white abalone shell material with known collection year (unknown collection month; A.H. Andrews, unpublished data). In general, the post-bomb $\Delta^{14}C$ records provide support for minimum levels in the SCB over time and confidence in pre-bomb classification for $\Delta^{14}C$ values below the 2 SD criterion.

Bomb radiocarbon dating

Estimated age was based on the measured $\Delta^{14}C$ values relative to the time where regional $\Delta^{14}C$ reference values were in agreement, leading to a pre-bomb period classification (Figure 6). The two $\Delta^{14}C$ values are consistent with the reference $\Delta^{14}C$ values from the SCB and below the 2 SD criterion (Table 1). Because the measured $\Delta^{14}C$ values were classified as pre-bomb, only a minimum age can be determined from the latest year these values were recorded in the reference series. Birth year and estimated minimum age was objectively based on the agreement of the measured $\Delta^{14}C$ values with the loess curve of the yelloweye rockfish $\Delta^{14}C$ record (similar to the Pacific halibut $\Delta^{14}C$ rise time and the 1959 $\Delta^{14}C$ value from Scripps Pier). Minimum birth year from this congruence would be 1959 for a minimum age of 51 years. A more conservative estimate of 49 years from the 95% CI (1961 = latest birth year for the measured $\Delta^{14}C$ values) is also possible, but given the uncertainty in the yelloweye rockfish $\Delta^{14}C$ record, it is unlikely.

The birth year calculated from the growth-zone derived age is consistent with the pre-bomb classification of the otolith core material. The 62-year growth-zone age estimate is supported by the minimum $\Delta^{14}C$ age of 51 years. These findings also provide a level of confidence in the growth zone interpretations from the otolith thin-section.

Discussion

The estimate of 62 years for the massive specimen reported here is similar to what may be the most reliable, prior age estimates. For giant sea bass approaching maximum size,

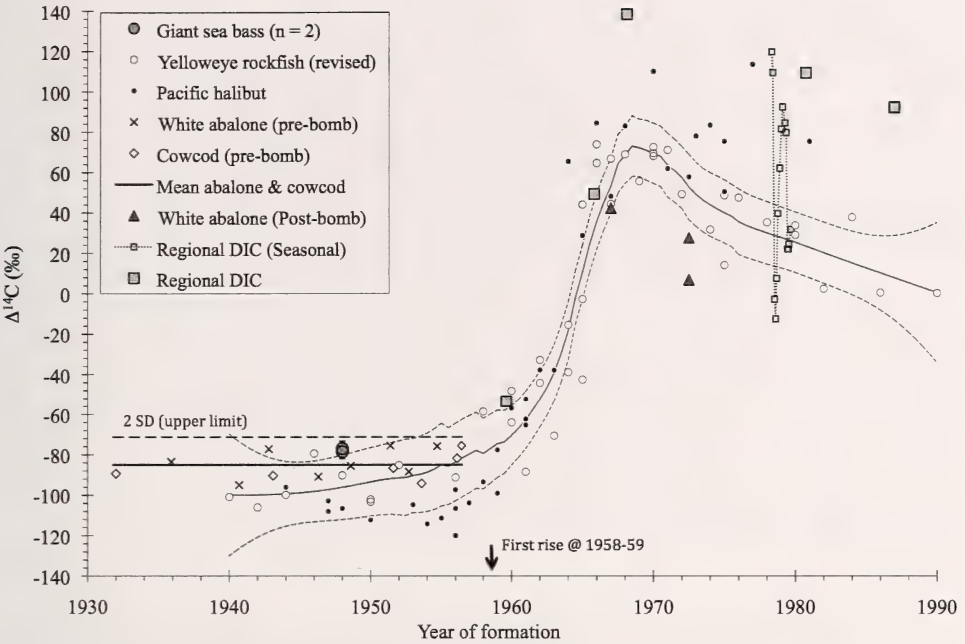

Fig. 6. Plot of two measured giant sea bass $\Delta^{14}C$ values from an otolith core estimated as 62 years old (birth year 1948), relative to changes in radiocarbon ($\Delta^{14}C$) from atmospheric testing of nuclear bombs over time as recorded by various $\Delta^{14}C$ reference records. Yelloweye rockfish (Kerr et al. 2004) and Pacific halibut (Piner and Wischniowski 2004) otoliths provide the nearest comprehensive reference chronology from the GOA. Pre-bomb $\Delta^{14}C$ values from white abalone shell and cowcod rockfish otoliths in the SCB provide a regional $\Delta^{14}C$ context. The revised yelloweye $\Delta^{14}C$ record (A.H. Andrews, unpublished data) and the Pacific Halibut record provide a time-specific reference for the common rise in $\Delta^{14}C$ in the northern Pacific Ocean (~1958–59). Mean $\Delta^{14}C$ from white abalone and cowcod rockfish, with a calculated 2 SD upper limit, provide a basis for classifying the measured $\Delta^{14}C$ values as pre-bomb (earlier than ~1958–59) using otolith core material of the massive giant sea bass specimen. A loess curve fitted to the yelloweye rockfish $\Delta^{14}C$ data (with 95% CI) provides a centralized graphical distribution for these data. Other $\Delta^{14}C$ reference records from DIC measurements within the SCB and off central California provide regional references for the post-bomb behavior of $\Delta^{14}C$ (Linick 1978, Druffel and Williams 1991, Williams et al. 1991).

reported age estimates on the order of 60 to 70 years were similar to our findings. Bomb radiocarbon dating produced a minimum estimate of approximately 51 years for this specimen, thus providing support for the age derived using growth zone counts. The early estimates of age were derived using outdated techniques on whole otoliths and it is uncertain how these numerical estimates were quantified. The otolith thin-sections used in this study provided regular growth increments that were easily quantifiable and similar in pattern to those of other polyprionid species with similar longevity estimates.

The combination of $\Delta^{14}C$ reference records provides evidence for a common $\Delta^{14}C$ rise time from bomb-produced radiocarbon. Despite the minor difference in mean pre-bomb $\Delta^{14}C$ levels between the GOA and the SCB, the rise times among $\Delta^{14}C$ records from the northeastern Pacific were similar and converge in 1958 to 1959. It is currently unknown what the specific rise time is for the SCB, but it is reasonable to assume that the timing is similar for the northeastern Pacific because of global similarities in the $\Delta^{14}C$ rise time (Druffel 2002). In addition, the data series from Scripps Pier provide evidence for a simultaneous $\Delta^{14}C$ rise at approximately 1959, similar to the yelloweye rockfish and

Pacific halibut records. Improved $\Delta^{14}C$ records within the SCB would provide greater confidence in estimating age from this approach, but it is unlikely that the minimum longevity estimate would change by more than a few years due to regional upwelling.

Several species of wreckfish (Polyprionidae) have been studied for age and growth. A single congener, *Stereolepis doederleini*, is a large demersal species of the northwestern Pacific whose life history is little known, but two species of the other genus (*Polyprion*) in this family, support important international fisheries and have been aged. Based on growth zone counts of otolith thin-sections, the maximum age for Atlantic wreckfish (*Polyprion americanus*) exceeds 70 years, with validation for the earliest growth from daily increments and margin type analyses (Peres and Haimovici 2004). For the New Zealand hapuku (*Polyprion oxygeneios*), age estimates from otolith thin-sections, supported by tag-recapture evidence of early growth, indicate a longevity exceeding 60 years (Francis et al. 1999). While members of the genus *Polyprion* are not ecologically similar to *S. gigas*, the age estimates from growth zone counts of otolith thin-sections provides evidence that such longevity is reasonable. Reports of a 100-year longevity in the literature and on the Internet, however, were a promulgation of an off-the-cuff estimate made in Fitch and Lavenberg (1971) that remains unfounded.

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Planktonic Larval Duration, Settlement, and Growth Rates of the Young-of-the-Year of Two Sand Basses (*Paralabrax nebulifer* and *P. maculatofasciatus:* fam. Serranidae) from Southern California

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Abstract.—Accurate estimates of Planktonic Larval Duration (PLD) have become critical to the modeling of larval dispersal and connectivity among ecological communities. Among those species where little information on larval duration is known are the spotted (*Paralabrax maculatofasciatus*) and barred (*P. nebulifer*) sand basses, two economically important species that have historically been the focus of marine recreational fisheries off southern California. PLD was determined by a count of the daily growth rings from the otolith core to the settlement check and age from the core to the otolith margin. Size at settlement was estimated by the size of the otolith from its core to the settlement mark based on the otolith size to body size relationship. Based on these significant relationships, mean size at settlement of our specimens was calculated to be 10.2 ± 1.6 mmSL for spotted sand bass and 9.1 ± 1.1 mmSL for barred sand bass. Mean PLD was 32.8 ± 2.2 days with a range from 28 to 37 days for spotted sand bass and 25.8 ± 2.2 days (range 21–30) for barred sand bass. Growth rates for the YOY of each species estimated by calculating the length-to-age relationships were 1.13 mm/day for spotted sand bass and 1.28 mm/day for barred sand bass. PLDs of approximately one lunar month and growth rates of about 1 mm/d seem to be common in those summer spawning fishes from San Diegan Province (warm temperate).

Introduction

In recent years, accurate estimates of planktonic larval duration (PLD) have become critical to the modeling of larval dispersal and connectivity among ecological communities (Miller and Shanks 2004, Levin 2006, Shanks 2009, Shanks and Eckert 2005, Cowen and Sponaugle 2009, Watson et al. 2010, Watson et al. 2011). Such studies, particularly on fishes, are often limited by the lack of PLD information, even on ecologically and economically dominant species off California (Shanks and Eckert 2005).

Among those species where little information on larval duration is known are the spotted (*Paralabrax maculatofasciatus*) and barred (*P. nebulifer*) sand basses, two economically important species that have historically been the focus of marine recreational fisheries off southern California. Both are warm temperate serranids with spotted sand bass ranging from Monterey, California south to Mazatlan, Mexico including the Gulf of California and barred sand bass occurring from Santa Cruz, California south to Todos Santos (23°23′N, 110°12′W), including Guadalupe Island (Miller and Lea 1972). In southern California, the spotted sand bass is restricted to shallow, warm-water areas such as lagoons, bays, and harbors where structure in the form of eel grass and rock relief occurs (Allen et al. 1995), whereas barred sand bass mainly inhabits the open coast near structure to depths of about 40 m (Hovey et al. 2002).

Aside from developmental studies based largely on laboratory reared specimens (Butler et al. 1982), little information exists on early life history in regards to PLD, settlement size, and daily growth rates of young-of-the year (YOY) of either of these two species.

Since the initial application of daily growth rings in the aging of larval fishes by Brothers et al. (1976), numerous studies have proven the validity and usefulness of this technique in the investigation of early life history characteristics (for reviews, see Campana and Neilson 1985). Spawning and settlement (Middaugh 1981, McFarland et al. 1985, Cordes and Allen 1997), growth rates (Geffen 1982, Neilson and Geen 1982), and planktonic duration (McFarland et al. 1985, Victor 1986) have all been studied using daily growth increments. The settlement check may be a result of the stress associated with a transition from a planktonic to a demersal life style, during which a change in growth or metabolic rate is recorded as a change in the deposition rate of the rings, resulting in the check (Gauldie 1991).

The purpose of this study was to examine aspects of the early life history of spotted sand bass and barred sand bass by using daily growth ring and settlement check analysis of young-of-the-year (YOY) specimens. Specifically, we estimate 1) planktonic larval duration (PLD), 2) age and length at settlement, and 3) average daily growth rates of these juvenile sand basses.

Methods

The YOY sand basses examined in this study were collected at two southern California locations at two separate times. The 27 juvenile spotted sand bass were from Agua Hedionda Lagoon (33°08′33″ N; 117°19′39″ W) and collected as a result of a single heat treatment at Encina Power Plant, in Carlsbad, CA on April 11, 2005 by the Vantuna Research Group of Occidental College. The 57 juvenile barred sand bass were collected using beam and otter trawls in San Diego Bay, CA (32°39′00″ N; 117°08′03″ W) over the period of October 1997 to April 1999 during California State University Northridge's (CSUN) fisheries utilization study for the U.S. Department of the Navy (Allen et al. 2002). All specimens were frozen and returned to CSUN (California State University, Northridge) for future workup.

In the laboratory, all of the fish were thawed, blotted dry, weighed to the nearest hundredth of a gram, and measured for standard length (SL) to the nearest tenth of a millimeter using calipers. For the barred sand bass some specimens, n = 33, whose otoliths had been previously extracted, were only measured to the nearest tenth of a gram and SL was measured to the nearest millimeter. After being weighed and measured, the sagittal otoliths were removed from all individuals. Otoliths were then mounted on glass slides sulcus-side down and polished using 3 um sand paper until daily bands near the core were visible. Otoliths were then covered in immersion oil for age and size determination. All measurements were completed using a compound microscope, camera, and image analysis software (Image-Pro Plus). Settlement checks, identified as abrupt changes in the width of daily bands at the time of settlement, were found in all specimens examined. PLD was determined by a count of the daily growth rings from the core to the settlement check. Size at settlement was estimated by the size of the otolith from the core to the settlement mark based on the otolith size to body size relationship.

Daily growth rings were double read on each otolith, and if readings were more than 10% different they were read a third time. If after the third reading, two of the three readings were still not within 10% of each other, that individual was not included in this

Table 1. Estimated Plankton Larval Duration (PLD) and size at settlement for the three species of *Paralabrax* from southern California.

Species	Planktonic Larval Duration		Settlement		
	Range (d)	Mean ± STD (d)	Size (mmSL)	N	Data Source(s)
Paralabrax maculatofasciatus	28–37	32.8 ± 2.2	10.2 ± 1.6	27	present study
Paralabrax nebulifer	21–30	25.8 + 2.2	9.1 ± 1.1	51	present study
Paralabrax clathratus	25–32	28.8 ± 2.3	9.4 ± 0.7	14	McClean 1999

analysis. If the two readings were within 10% of one another, then the mean of the two readings was used in statistical analyses.

Validation of daily growth rings in the genus *Paralabrax* was accomplished and presented in Cordes and Allen (1997) in their study on the closely related congener, the kelp bass (*P. clathratus*). Cordes and Allen (1997) also determined that daily ring deposition began on the third day of life. Therefore, two days were added to each ring count in all age estimates in spotted sand bass and barred sand bass. This correction accounts for the delay in daily growth ring formation in the larval otolith before yolk absorption.

Age (days) and length (mmSL) relationships in these young stages were examined by correlation and were modeled by linear regression. Both settlement age and size at settlement were determined independently for each specimen. The measurement of settlement age was based on the pre-settlement ring count (+ 2 days), and size at settlement was based on the otolith radius to somatic length regression from measured standard length. Due to the independent determination of these measurements we felt justified in using the size and age at settlement data to "anchor" the regression line for each species. This procedure effectively doubled the sample sizes and greatly enhanced the fit to the predictive growth models. All statistics, calculations, and graphics were prepared using Excel 2007 (version 12, Microsoft Corp.), and Statistica (version 10, StatSoft, Tulsa OK).

Results

In these two species, as well as many others, otolith size is closely related to the body size of the individual. In this study, predictably, a strong linear relationship existed between otolith radius and standard length for both species (spotted sand bass, $n = 27$, $R^2 = 0.91$, $p < 0.0001$; barred sand bass, $n = 51$, $R^2 = 0.93$, $p < 0.0001$). Based on these significant relationships, mean size at settlement of our specimens was calculated to be 10.2 ± 1.6 mm SL for spotted sand bass and 9.1 ± 1.1 mm SL for barred sand bass. Mean PLD was 32.8 ± 2.2 days with a range from 28 to 37 days for spotted sand bass and 25.8 ± 2.2 days (range 21–30) for barred sand bass (Table 1).

Likewise, the age to length relationships for the YOY of both species were highly significant. The age-to-length relationship of spotted sand bass was best described by the linear equation: $A = 0.87L + 24.01$ ($R^2 = 0.98$) where A = age in days and L = standard length in mm (Figure 1A). Age to length in YOY barred sand bass was also similarly described by the linear relationship: $A = 0.74L + 19.66$ ($R^2 = 0.95$) (Figure 1B).

Growth rates for the YOY of each species were estimated by calculating the length-to-age relationships (Table 2). The significant length-to-age regression equation was calculated as: $L = 1.13(A) - 26.34$ ($R^2 = 0.98$) for spotted sand bass and $L = 1.28(A) - 23.43$ ($R^2 = 0.95$) for barred sand bass. Therefore, YOY growth rates for these samples, as

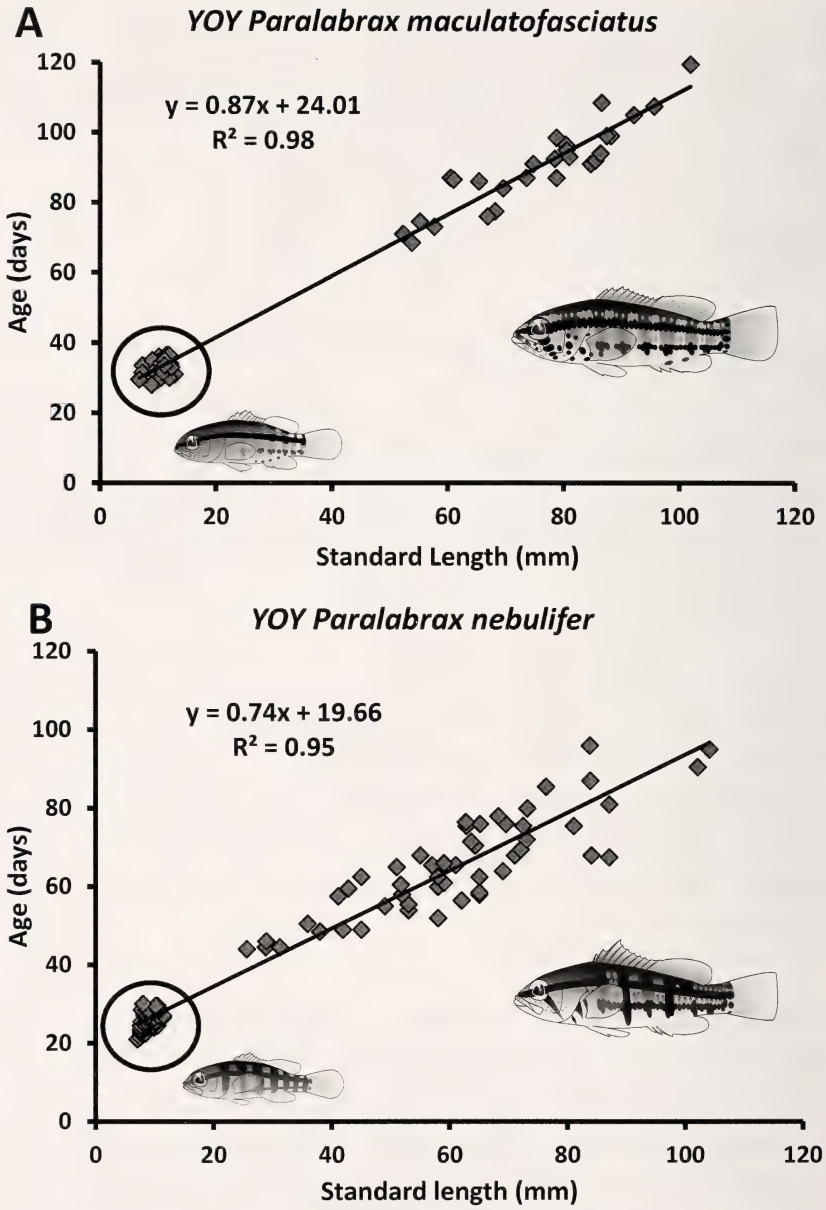

Fig. 1. Relationship of age (days) to standard length (mmSL) in YOY *Paralabrax maculatofasciatus* (A) and *P. nebulifer* (B) including age and independently derived (back calculated) size at settlement estimates (indicated by black circles) from otolith radius measurements.

indicated by the slopes of the lines, were 1.13 mm/day for spotted sand bass and 1.28 mm/day for barred sand bass.

Discussion

PLD, age and size at settlement for the two sand basses in this study were remarkably similar to those estimated for their congener the kelp bass. All three *Paralabrax* are

Table 2. Estimated young-of-the-year (YOY) length-age relationships and growth rates (mmSL/d) of the three species of *Paralabrax* from southern California.

Species	YOY Length (mmSL) to Age (d)	YOY Age (d) to Length (mmSL)	R^2	Growth rate (mmSL/d)	Size Range (mmSL)	N	Data Source(s)
Paralabrax maculatofasciatus	L = 1.13(A) − 26.34	A = 0.87(L) + 24.01	0.984	1.13	7–102	54	present study
Paralabrax nebulifer	L = 1.28(A) − 23.43	A = 0.74(L) + 19.66	0.949	1.28	7–104	102	present study
Paralabrax clathratus	L = 0.41(A) − 2.01	A = 2.16(L) + 8.15	0.875	0.41	8–40	127	Cordes 1992, McClean 1999

summer spawners and PLD for all three were approximately a lunar month (28 d) with size at settlement centered near 10 mm SL (Table 1). Interestingly two additional economically important, broadcast spawning fishes from southern California have also been shown to have PLD at or near the lunar month including the California halibut (*Paralichthys californicus*, PLD = 27.9 ± 4.0 d, Sears-Hartley 1994) and white seabass (*Atractoscion nobilis*, PLD = 29.1 ± 2.4 d, Donohoe 1997).

Sears-Hartley (1994) estimated that California halibut, a spring to early summer spawning species, settled at similar sizes (8.6 ± 1.2 mm SL) to those of the three *Paralabrax* in the waters off southern California. However, white seabass, also a summer spawning fish, appears to settle along the open coast at smaller sizes (7.3 ± 1.5 mm SL) than the three *Paralabrax* species and California halibut off southern California (Donohoe 1997).

Shanks et al. (2003) presented slightly different PLD estimates for two of the species mentioned above. They reported a PLD for white seabass of 32 d with a range of 29–35 d based on samples taken from the northern portion of the Southern California Bight (Franklin 1991, Allen and Franklin 1992). This estimate of PLD was slightly higher than that estimated by Donohoe (1997) from specimens captured in the southern portion of the Bight. The estimate of a PLD for spotted sand bass of 22 d ranging from 17–27 d was based on earlier work on fishes collected in Magdalena Bay, Baja California Sur, Mexico. Our recalculation of this previous estimate of PLD was 21 d (20.8 ± 3.5) for spotted sand bass from near the southern end of their range was significantly lower than that presented for spotted sand bass from southern California near the northern end of their range. The corresponding size at settlement (13.5 + 0.1 mm SL) of the Magdalena Bay YOY was higher indicating faster growth in warmer waters of this southern locale (J.T.W. Smith and L.G. Allen, unpub. data).

Our estimates of age at settlement for the *Paralabrax* species compare favorably to the minimum age at transformation of laboratory reared specimens presented in Butler et al. (1982). In their study, the earliest transformed individuals were 28 days for all three species of *Paralabrax*. Sizes at transformation were reported as total body length (mm TL) and once converted to mm SL tended to be slightly less than the sizes reported for field caught specimens in the present study. According to Butler et al. (1982), kelp bass reared in the laboratory at 19 °C first transformed at 8.0 mmSL (compared to 9.4 mm SL reported here). Spotted sand bass reared at 21 °C first transformed at about 8.0 mm SL (compared to 10.2 mm SL), and barred sand bass also at 21 °C first transformed at about 9 mm SL which was comparable to the 9.1 mm SL found in the current study.

From our current data, after settlement, YOY spotted sand bass grew at 1.13 mm/day while YOY barred sand bass grew slightly faster at 1.28 mm SL/d off southern California. These rates are over 2-times higher than that of the YOY kelp bass, which were estimated to grow at approximately 0.41 mm/day (recalculation using data from Cordes 1992 and McClean 1999). Prior to settlement, larvae of both sand bass species only grew at a much slower rate of approximately 0.3 mm/day. We should also note that the age-to-length regression model for YOY kelp bass reported herein was based on specimens up to 40 mm SL (A = 2.16(L) + 8.15, Table 2) and is a recalculation of that found in Cordes and Allen (1997) where the reported age-length model was found to be in error.

In closing, we offer the simple observation that PLDs of approximately one lunar month and growth rates of about 1 mm/d seem to be common in those summer spawning fishes from San Diegan Province (warm temperate) that have been studied thus far.

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An Abnormally Colored Redbanded Rockfish, *Sebastes babcocki*

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Four species of eastern North Pacific rockfishes of the genus *Sebastes* are easily distinguished from their congeners by the coloration characteristic of broad lateral banding. These species are the Tiger Rockfish, *S. nigrocinctus*; Treefish, *S. serriceps*; Flag Rockfish, *S. rubrivinctus*; and Redbanded Rockfish, *S. babcocki*.

These species are shown to be closely related and have been placed in the *Sebastichthys* clade by Hyde and Vetter (2007). The Tiger Rockfish and Treefish are distinguished by differences in their general body form and coloration of the banding pattern. The Treefish invariably exhibits alternating black, brown, or dark green and yellow bars, and the lips are distinctly pink to red (rarely without coloration). The Tiger Rockfish manifests greater variation in banding with the darker bars being primarily red, but can vary from reddish-black to reddish-brown. The alternating lighter bars are mainly white, but occasionally show a reddish hue. The Flag and Redbanded rockfishes possess alternating red and white bars (Love et al., 2002). The general similarity in body shape and color pattern between the latter two species was cause for them to be considered conspecific from shortly after the year of description of *S. babcocki* (Thompson, 1915) until Rosenblatt and Chen (1972) clarified the distinction of these species and pointed out a number of meristic and morphological characteristics that definitively separate these two species. The Flag Rockfish was described in the late 1800's (Jordan and Gilbert, 1880).

On 10 February 2004, a uniformly red rockfish (Fig. 1) was encountered by Diane Haas, then a Fishery Technician with the Pacific States Marine Fisheries Commission, during routine sampling of commercial groundfishes. The F/V *Alex Kevin D* had unloaded three market categories of groundfishes: Longspine Thornyhead, *Sebastolobus altivelis*; Shortspine Thornyhead, *S. alascanus*; and Blackgill Rockfish, *Sebastes melanostomus*, which were to be sampled. The uniformly red rockfish was included in the Blackgill Rockfish market category, where a 50 pound cluster was randomly selected from a total landing of 764 pounds. The species composition of the cluster consisted of Blackgill Rockfish, one Rosethorn Rockfish, *S. helvomaculatus*, and the uniformly red rockfish. Also present in the landing, but not included in the sample, were at least two Rougheye Rockfish, *S. aleutianus*, (from California the species is now considered as Blackspotted Rockfish, *Sebastes melanostictus* [Orr and Hawkins, 2008]). The fishes were taken in Monterey Bay (ca. 36°47′ N, 122°07′ W) by commercial longline gear on the continental slope at a depth of 200–260 fathoms (366–475 meters).

The red rockfish was not immediately identifiable with any of the red-colored, outer shelf-upper slope rockfishes normally encountered off central California and was

Figure 1. Uniformly red Redbanded Rockfish, *Sebastes babcocki*, from Monterey Bay, sampled from F/V *Alex Kevin D*, 10 February 2004.

procured for further analysis in the laboratory. Upon examination of the general morphology of the specimen, we determined it to be a Redbanded Rockfish, typical in all aspects of *S. babcocki* with the exception of coloration (i.e., essentially uniformly red and lacking vertical red and white banding). The rockfish measured 557 mm TL, 546 mm FL, and 465 mm SL, and weighed 2564.0 g when fresh. The fish was a mature male and possessed a large genital papilla. Counts were: D XIII, 14; A III, 7; Pectoral L 9/18, R 8/18 (unbranched rays/total rays); Gill rakers L 9+22=31, R 8+21=29. The age was estimated to be 57 years from otoliths using the break and burn method (D. Pearson, NOAA, NMFS, pers. comm.). The general morphology of the preopercular bone was typical for the species; the third spine is acutely hooked downward in *S. babcocki*

Figure 2. General morphology of preopercular bone from Redbanded Rockfish, *Sebastes babcocki*; note configuration of 3rd preopercular spine. Bone from specimen (548 mm SL, 655 mm TL) taken off Davenport, Calif., 170–215 fm., F/V *Sunrise III*, set gill net, 5 April 1995.

(Fig. 2), a condition we know of in only one other species, the Semaphore Rockfish, *S. melanosema*.

Correct identification of any fish species is extremely important due to the implications it may have in fisheries management. The species compositions determined during routine sampling of market categories are used to estimate total landings of component species. These estimates, along with biological information collected with each species, such as length and age composition, are utilized in stock assessments. Because individual species often have different quotas and fishing regulations, accurate identification is critical to the regulatory process. For instance, a number of red–colored rockfishes fall under the category of shelf rockfishes while Redbanded Rockfish is categorized as a slope species. The misidentification of a quota-managed species could result in delayed fishery closures (Faunce, 2011).

Acknowledgements

We thank the crew of the F/V *Alex Kevin D* for the anomalously colored rockfish (*S. babcocki*), Don Pearson for ageing the specimen, and Donna Kline for providing useful comments.

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Reproduction of the Yellow-backed Spiny Lizard, *Sceloporus uniformis* (Squamata: Phrynosomatidae) from California

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The reproductive cycle of *Sceloporus uniformis* was studied by a histological examination of gonads collected from five California counties: Inyo, Kern, Los Angeles, Riverside and San Bernardino. Males followed a testicular cycle in which sperm production (spermiogenesis) started in March and was completed by August. The smallesr reproductively active male measured 79 mm SVL. Females were reproductively active from March into July. Mean clutch size (n = 21) was 6.48 ± 2.2 SD, range = 3–10. The smallest reproductively active female (enlarged follicles >5 mm) measured 78 mm SVL. Histological evidence is presented (oviductal eggs and concomitant yolk deposition) that multiple clutches are produced by some females of *S. uniformis*.

The yellow-backed spiny lizard, *Sceloporus uniformis* Phelan and Brattstrom, 1955, occurs primarily in the Mojave and Great Basin Deserts of California, Nevada, Utah, and northwestern Arizona, as well as the Central Valley of California from near sea level to around 1,520 m (Conrad 2009). Schulte et al. (2006) elevated the subspecies *Sceloporus magister uniformis* to *Sceloporus uniformis*. Previous information on its reproductive cycle are one or more clutches of 4–19 eggs deposited from May to August (Conrad 2009). In Nye County, Nevada, a mean of 7.0 eggs was produced (Tanner and Krogh 1973). In southern Utah (Washington County), reproduction occurs from May to July with two clutches averaging 6.2, range 2–9 eggs (Tinkle 1976). Five adult *S. uniformis* females from the Providence Mountains, San Bernardino County, California collected between May 22 and June 11 contained enlarged ovarian follicles (Johnson et al. 1949). The purpose of this paper is to provide additional information on the reproductive cycle of *S. uniformis* from a histological examination of gonads. Categorization of the reproductive cycle including period of sperm production, timing of yolk deposition and number and sizes of clutches produced provides important information in formulating conservation policies for lizard populations (Gibbons 1994). Due to the difficulty in obtaining collecting permits for large collections of monthly lizard samples, utiliization of museum collections for obtaining reproductive data has become increasingly important.

A sample of 239 *S. uniformis* consisting of 105 adult males (mean SVL = 100.8 mm ± 9.6 SD, range: 78–124 mm), 51 adult females (mean SVL = 91.5 mm ± 7.6 SD, range: 77–108 mm), 75 juveniles (mean SVL = 56.3 mm ± 10.6 SD, range: 37–56 mm) and eight neonates (mean SVL = 32.1 mm ± 4.0 SD, range: 24–34 mm) collected 1921 to 1980 was examined from the herpetology collection of the Natural History Museum of Los Angeles County (LACM), Los Angeles, California, USA (appendix).

The left gonad was removed and embedded in paraffin. Histological sections were cut at 5μm and stained by hematoxylin followed by eosin counterstain (Presnell and Schreibman 1997). Enlarged follicles > 5 mm length and oviductal eggs were counted. Histology slides were deposited in LACM. The snout-vent length (SVL) of each specimen was measured from the tip of the snout to the posterior margin of the vent. An unpaired

Table 1. Monthly stages in the testicular cycle of 105 *Sceloporus uniformis* from California.

Month	N	Regression	Recrudescence	Spermiogenesis
February	1	0	1	0
March	14	0	10	4
April	25	1	2	22
May	28	0	2	26
June	14	2	0	12
July	9	8	0	1
August	8	6	1	1
September	1	0	1	0
October	5	1	4	0

t-test was used to compare *S. uniformis* male and female mean body sizes (SVL) and the relationship between clutch size and female SVL was examined by linear regression analysis utilizing Instat (vers. 3.0b, Graphpad Software, San Diego, CA).

Mean body size (SVL) for adult males was significantly larger than for adult females (unpaired *t* test, $t = 6.1$, $df = 156$, $P < 0.0001$). Three stages were noted in the testicular cycle: (1) Regression, germinal epithelium is greatly reduced in size and consists of 1–3 layers of spermatogonia and interspersed Sertoli cells; (2) Recrudescence, a proliferation of germ cells occurs in preparation of the upcoming period of sperm formation; primary and secondary spermatocytes predominate. Spermatids are common in late recrudescence. (3) Spermiogenesis, lumina of the seminiferous tubules are lined by sperm and/or clusters of metamorphosing spermatids. Stages in the testicular cycle by month are in Table 1. The main period of spermiogenesis occured in April–June. *Sceloporus uniformis* with regressed testes predominated in July–August. Testicular recrudescence initiated in summer and was completed the following spring (Table 1). The smallest reproductively active male (spermiogenesis) measured 79 mm SVL (LACM 17242) and was collected in Los Angeles County during March.

Four stages were noted in the ovarian cycle of *S. uniformis* (Table 2): (1) Quiescent, no vitellogenic granules are noted in the ooplasm; (2) Early yolk deposition, basophilic yolk granules in the ooplasm; (3) Enlarged ovarian pre-ovulatory follicles (> 5 mm); (4) Oviductal eggs. The period of ovarian activity extended from March into July. Mean clutch size for 21 gravid females of *S. uniformis* is 6.48 ± 2.2 SD, range = 3–10. The smallest reproductively active female (three enlarged follicles > 5 mm) measured 78 mm SVL (LACM 17252) and was collected in Los Angeles County in June. Linear regression analysis revealed a significant positive correlation between female SVL ($n = 21$) and clutch size ($Y = -6.25 + 0.138X$, $r = 0.512$, $P = 0.018$). There was evidence that some *S. uniformis* females produce multiple clutches in the same reproductive season as both LACM 63819 from Kern County collected in March and LACM 96089 from San Bernardino County collected in May contained oviductal eggs and concomitant yolk deposition for a subsequent clutch.

Sceloporus uniformis exhibits a testicular cycle with timing typical of many other phrynosomatid lizards from western North America in which spermiogenesis occurs in spring, followed by late summer regression and recrudescence (recovery) initiated in autumn and completed the following spring (Goldberg 1974, 1975, 1977). Likewise, the ovarian cycle of *S. uniformis* is similar to that of many other North American temperate zone phrynosomatid lizards which initiate yolk deposition in the spring and complete it in summer with one or two egg clutches produced (Goldberg 1974, 1975, 1977).

Table 2. Monthly stages in the ovarian cycle of 51 *Sceloporus uniformis*: from California. *LACM 4516 and ** LACM 17251 contained damaged follicles or oviductal eggs that could not be counted.

Month	N	Quiescent	Early yolk deposition	Enlarged follicles > 5 mm	Oviductal eggs
March	7	1	4	0	2
April	11	2	5	4	0
May	10	2	1	2	5*
June	14	5	1	4**	4
July	6	4	0	0	2
August	1	1	0	0	0
September	1	1	0	0	0
October	1	1	0	0	0

Sceloporus uniformis of presumed neonate sizes (24, 28, 30 mm SVL) first appeared in July. They were also collected in August (34, 34, 35 mm SVL) and September (33, 35 mm SVL). The appearance of hatchlings in July is earlier than appearance of *S. uniformis* hatchlings in Utah which first appeared in August (Tinkle 1976). However, Tanner and Krogh (1973) reported hatchlings of *S. uniformis* appeared in late July in Nevada.

Previous reports on clutch sizes in *S. uniformis* from Utah mean = 6.2, range = 2–9 (Tinkle 1976), and Nevada mean = 7.0 (Tanner and Krogh 1973) are close to the mean of 6.5 range = 3–10 reported herein. The reports of larger clutch sizes (18, 19 respectively) for *S. uniformis* are from field guides (Stebbins 1954; Lemm 2006; Stebbins 2003; Conrad 2009) and likely reflect *Sceloporus magister* sensu stricto, not *S. uniformis*. There is a report of 19 eggs from *S. magister* from Maricopa County, Arizona in another field guide (Brennan and Holycross 2005). Also, males of *S. magister* reach maturity at 95 mm SVL (Parker and Pianka 1973) as opposed to 79 mm SVL reported for *S. uniformis* herein.

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Appendix

Sceloporus uniformis from California examined from the herpetology collection of the Los Angeles County Museum of Natural History (LACM), Los Angeles County, California.

Inyo: 36665, 52996, 27182, 27183, 75267, 123376, 123377.

Kern: 8570, 27184, 63817–63824, 63827, 63828, 69816, 69865, 69867, 69869, 95989, 95990, 95991, 23378.

Los Angeles: 4516, 4517, 4521, 4522, 4523, 17135, 17222, 17224–17227, 17233–17238, 17242–17244, 17277, 17251–17254, 17263, 17264, 27186, 27189, 52937, 61874, 74180, 95992–95995, 123375.

Riverside: 17276, 22269–22274, 22276, 22278, 22279, 22281, 22283, 22285, 22286, 22288–22298, 22300–22312, 22316, 22318, 22320, 22322, 22323, 22325, 22326, 52938, 52940, 52942, 73568, 73569, 73572, 73574, 73579–73581, 73583, 73683, 95998–96000, 96002, 96003, 96005, 96006, 96012, 96016, 96017, 96020–96022, 96027, 96028, 96031, 96035, 96038, 96041, 96044, 96046, 96047, 96050, 96052, 96055–96057, 96113, 138085.

San Bernardino: 4526, 4527, 17132, 17136, 17265–16267, 17271, 17274, 17275, 21653, 21654, 21657–21659, 21661, 22277, 22278, 22313, 23254, 23258–23267, 36587–36590, 63814–63816, 63826, 64003, 64004, 67317, 74200, 96061, 96063, 96065–96067, 96069, 96072, 96073, 96076, 96078–96084, 96086, 96087, 96089, 96091–96096, 96098, 96100, 96105, 96106, 96108, 96111, 96117, 96123, 96124, 96127, 96131, 96132, 115620, 115622, 115623, 115625, 122058, 122432, 122433, 123375, 171372, 171376.

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ABSTRACTS FOR FRIDAY SESSIONS

1. A VASCULAR FLORA OF THE BALLONA WETLANDS AND ENVIRONS

E. Read. E Read and Associates, Inc., Orange, CA 90293.

The Ballona Wetlands have been the subject of conservation and restoration planning efforts for at least 40 years. Numerous botanical surveys have been conducted during that time but results of these surveys have been confined to consultant reports. Here we summarize floristic surveys and voucher collections, with notes on historical and rare occurrences. A total of 396 species are recorded for the study area, of which 42% are not native to California. This proportion of non-native species in the flora is significantly higher than for California as a whole (17%). Of the 228 native species in the study area, 25 percent appear to have been extirpated and are known only from collections prior to major hydromodifications in the region. Many of the extirpated species are associated with streams, wet meadows, and pastures, but there are exceptions. These include Ballona cinquefoil (*Potentilla multijuga*), coastal dunes milkvetch (*Astragalus tener* var. *titi*), Ventura marsh milkvetch (*Astragalus pycnostachyus* var. *lanosissimus*), and salt marsh bird's beak (*Chloropyron maritimum* ssp. *maritimum*). One species (Ballona cinquefoil) is believed extinct, but other species extirpated from the Ballona region are still extant elsewhere and could be re-introduced to the Ballona Wetlands with restoration of a diversity of habitat types and control of highly invasive exotic species.

2. ECOPHYSIOLOGY OF NATIVE PLANT SPECIES AND IMPLICATIONS FOR RESTORATION

Philippa M. Drennan. Loyola Marymount University, Department of Biology, Los Angeles, CA, 90045.

Restoration alternatives for the Ballona Marsh range from a 'maintenance-of-the-*status-quo*' alternative to those that significantly modify both tidal and freshwater regimes. The greater physiological tolerance of native wetland species for salinity and/or flooding support the introduction of significant tidal and freshwater influence to reduce the cover of non-native species in this urban wetland. Ecophysiological studies, e.g., of the dominant *Salicornia virginica*, suggest that determination of optima and tolerance limits should also include alternation of conditions (with a tidal or seasonal periodicity) to predict field outcomes. Grown under constant conditions *S. virginica* has a lower optimum substrate salinity than *Jaumea carnosa* a species found predominantly along the edges of the tidal channels. However, *S. virginca* tolerates higher substrate salinities than *J. carnosa*, especially if periods of high substrate salinity alternate with periods of decreased salinity. Consistent with these results is the observation that increased tidal flushing associated with improved tide gate functioning has resulted in a decline in *J. carnosa* in some areas. The mechanism for the tolerance of alternating salinities in *S. virginica* is not known but probably contributes to the widespread success of the species at Ballona. Planning for some areas within the restoration that have relatively stable conditions of salinity and flooding could possibly increase diversity. Ecophysiololgical studies will also be used to predict future responses of restored habitat to climate change in the Ballona Wetlands, especially sea-level rise.

3. DYNAMICS OF A MUTED TIDAL SYSTEM AND THE EFFECTS ON INVERTEBRATE AND FISH ASSEMBLAGES

K.K. Johnston, E. Del Giudice-Tuttle, and I.D. Medel. Santa Monica Bay Restoration Commission, Los Angeles, CA 90045.

Coastal wetlands are unique transitional areas containing diverse groups of organisms idiosyncratically adapted to living in this highly dynamic and tidally influenced interface between fresh and salt water. In southern California, significant anthropogenic stressors and impacts have modified many of these coastal

wetland systems significantly; in some cases, such as the Ballona Wetlands Ecological Reserve (BWER), ecosystem functions have been lost primarily due to hydrologic modifications.

The first two years of the Ballona Wetlands Baseline Program assessed the functionality of the muted tidal system in the salt marsh habitats by evaluating the abundances of fish and benthic invertebrates through beach seines, minnow traps, and sieved sediment cores. The presence or absence of certain taxa within the tidal channels can indicate water quality, identify anthropogenic stressors to the estuary, and gauge the potential to support other trophic levels.

Both the invertebrate and fish species assemblages were found to be consistent with those of southern California salt marshes, but with atypical relative abundances that were both temporally and spatially variable. The muted effects of the tide gates and altered hydrology has reduced habitat availability and modified the community structure for these taxa. The results of these analyses will inform adaptive restoration and management actions for the BWER. Future assessments will study the impacts of these results on higher trophic levels, along with continued monitoring to assess species shifts and change in site use over time.

4. RATES OF RETURN ON INVESTMENT: FRESHWATER HABITAT CREATION AND TRENDS IN BIRD DIVERSITY

D.S. Cooper[1] and E. Read[2]. [1]Cooper Ecological Monitoring, Inc.; [2]E Read and Associates, Inc.

The 51-acre Ballona Freshwater Wetland System (BFWS) was constructed as mitigation for direct impacts of the Playa Vista development on wetlands within an abandoned airport, and anticipated impacts from restoration of the Ballona estuary and salt marsh. The construction cost of the BFWS was more than $18 million. Annual maintenance and monitoring costs, which includes compliance with requirements of the local vector control district plus permit conditions from four different regulatory agencies, are about $400,000. The science of constructed freshwater wetlands was in its infancy when the BFWS was designed in the early 1990s, and therefore numeric objectives for wildlife use were conservative. However, monitoring data have shown rapid colonization of the wetlands by avifauna. Twelve common avian species, such as red-winged blackbird and mallard, were observed breeding in the first year of monitoring in 2003. By the ninth year of monitoring in 2011, a total of 30 species had been observed breeding, including one endangered species (least Bell's vireo) and several species of regional conservation concern including common moorhen, least bittern, cinnamon teal, and Virginia rail. These data suggest that while constructed wetlands in urbanized watersheds can be costly, with appropriate design and location they can have an important role in conservation planning and recovery of endangered species.

5. AN ADAPTIVE APPROACH TO TERRESTRIAL VERTEBRATE MONITORING: RESULTS AND IMPLICATIONS FOR THE BALLONA WETLANDS ECOLOGICAL RESERVE

I.D. Medel, E. Del-Giudice Tuttle, and K.K. Johnston. Santa Monica Bay Restoration Commission, Los Angeles, CA 90045.

Terrestrial vertebrate populations play important roles in thriving ecosystems. Throughout the last century, the Ballona Wetlands Ecological Reserve has experienced a decline in native vertebrate populations and diversity due to degradation and fragmentation of habitat and the introduction of non-native species. The objective of the Baseline Assessment Program's (BAP) terrestrial vertebrate surveys was to provide information on species' presence and site use.

Year 1 monitoring strategies were implemented for several terrestrial vertebrate groups including: small and large mammals, herpetofauna, and avifauna. Quantitative comprehensive avifauna monitoring was conducted for the first time across multiple years. Sherman traps for small mammals were discontinued for year 2, with the exception of special status targeted surveys, due to low capture rates and high effort. A transition was made through adaptive monitoring to assess large mammals through motion cameras for relative abundances in specific areas. Herpetofauna monitoring during year 1 captured three species of lizard in drift-net arrays. Several expected taxonomic groups were not captured, leading the BAP to modify protocols to address the data gap through coverboard arrays. The revised protocols resulted in increased capture rates of seven species and two additional taxonomic classes (e.g. amphibians and

snakes). Results suggest site use to be strongly species-dependent, varying from site-wide to highly localized.

The success of the BAP's adaptive monitoring will inform decisions regarding long-term site-assessments. This approach optimizes data quality to account for specific site characteristics and variations in capture success rates. Collected data will contribute to the restoration planning of Ballona.

6. ANTIBIOTIC RESISTANCE GENES IN BACTERIAL ISOLATES FROM THE DEL REY LAGOON AND BALLONA WETLANDS

Gary Kuleck, John H. Dorsey, Christopher Leary, and **Stephanie Kawecki**. Loyola Marymount University, Department of Biology, Los Angeles CA, 90045.

Antibiotic resistance genes (ARG) have been classified as a biological pollutant, posing both a public health risk and environmental threat. The presence of these genes in coastal wetlands in Southern California has been documented but determining the extent of their influence on human health and ecosystems depends on an assessment of their presence, persistence and dissemination properties. As a first step, we conducted studies to identify their bacterial hosts and quantitate their relative abundance. Initial screenings were conducted at Del Rey Lagoon: subsequently we examined differences in bacterial isolates between flood and ebb tides at the Ballona Wetlands.

Screening methods were developed to identify bacterial isolates harboring ARGs. Molecular analysis was performed to identify specific genes borne by screened bacterial isolates. Using validated controls against tetracycline (tet^R) resistance genes, we were able to identify multiple bacterial isolates containing tet^R genes. Differences were also determined when comparing the abundance of bacteria insensitive to multiple antibiotics during flood and ebb tidal flows. Further molecular analysis will allow us to identify other genes in multi-antibiotic insensitive isolates. Future work involves comparing ARG abundance upstream in an effort to determine whether this trend is being seen due to urban runoff or if other sources are involved. With the growing concern for antibiotic resistant bacteria in our environment, studies such as these are crucial in understanding its source and abundance in order to determine its role in public and environmental health.

7. CARBON SEQUESTRATION IN SOUTHERN CALIFORNIA SALT MARSHES: LESSONS (TO BE) LEARNED

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One option to offset the rise in atmospheric CO_2 resulting from anthropogenic activities is to capture and store CO_2 in long-lived ecosystem carbon pools, including woody biomass and soils. There is a growing interest in capitalizing on this biosequestration through emerging carbon markets to generate revenue for ecosystem conservation and restoration projects. Tidal wetlands, including salt marshes, may be particularly well suited in this regard as a result of flooded, anaerobic soil conditions that limit decomposition and lead to the accumulation of soil organic carbon. However, these same soil conditions can lead to the production of CH_4 and N_2O, two potent greenhouse gases, which could negate the carbon sequestration potential in wetlands. Despite the importance of coastal salt marshes, and their restoration, in southern California, there is currently very little information on the potential for carbon sequestration in these ecosystems. We quantified soil organic carbon storage and CH_4 flux in 5 salt marshes located between Santa Barbara and Tijuana. Our results show that organic carbon content decreases with soil depth and that these sites store soil carbon at densities comparable to salt marshes in other regions. Comparisons between natural and restored habitats demonstrate that soil organic carbon does not always accumulate based on predictable trajectories through time, suggest that site-specific factors are crucial for understanding carbon sequestration following restoration. Across all locations, rates of CH_4 flux to the atmosphere were negligible, suggesting that this greenhouse gas does not likely offset soil carbon sequestration in these ecosystems.

8. LESSONS LEARNED FROM RESTORATION OF THE BOLSA CHICA WETLANDS AND BATIQUITOS LAGOON

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System-scale coastal wetland restoration and enhancement has a relatively brief history in Southern California. The first major coastal wetland restoration was completed at Batiquitos Lagoon in December 1996. A decade later, in August 2006, the Bolsa Chica wetland restoration was completed; and tidal influence was restored to the previously closed wetlands. Long-term monitoring of these two restored systems has facilitated the development of a greater understanding of the post-restoration evolution of restored coastal wetlands. Patterns of physical development in the coastal systems have included erosion and accretion; as well as tidal muting and lag differ between Batiquitos Lagoon and the Bolsa Chica wetlands. However, in retrospect, the processes leading to the manifestations of physical change were predictable; and thus, the resultant patterns of physical development could likely have been determined through an iterative process of modeling through a stepwise progression of physical conditions. Similar to physical evolution patterns, biological developments within the two wetland systems exhibit some shared characteristics and some differences. Among the most important shared feature has been the non-linear development of biological communities with prior development of environmental structure being a critical prerequisite to the recruitment of some species to the systems. Differences between biological development within the systems can generally be attributed to the differing extent and representation of habitats present, as well as the differences in wetland scale and continuity of restored habitats to existing established coastal wetlands.

9. LESSONS LEARNED FROM RESTORATION OF THE SAN DIEGUITO LAGOON WETLANDS

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Southern California Edison (SCE) is restoring to tidal wetland portions of upland contiguous to San Dieguito Lagoon (SDL) as partial mitigation for impacts due to the operation of the San Onofre Nuclear Generating Station (SONGS). We provide five examples of lessons learned at SDL during construction and early post-construction that pertain to both physical and biological elements of the project. First, an often untested assumption is that physical elements of restoration projects will behave according to modeled expectations. Modeling during the design phase suggested maintenance dredging would be required approximately every year to keep the inlet open to tidal exchange. However, the inlet has remained open since May 2008 without maintenance indicating that it performing better to this point than model expectations. Second, native species were planted with the goal of expediting plant establishment. However, vegetation planted in some areas graded to a high elevation with little topographic relief performed poorly, emphasizing the need to take the effects of constructed topography into account in restoration planning. Third, recently planted cordgrass was discovered infested with scale insects that may impede successful plant establishment. The inspection of plants prior to planting may alleviate this problem. Fourth, during the later stages of construction, much of the constructed habitat provided some resource value to wetland biota with over 100 species of birds reported in recently restored areas. Finally, these examples illustrate that monitoring during construction to identify trends in wetland development will inform adaptive management and improve the chances of success of restoration projects.

10. RESTORATION ISSUES AT BALLONA MARSH

Camm C. Swift[1] and David K. Jacobs[2]. [1]Cardno ENTRIX (Retired), 201 North Cesar Chavez, Suite 203, Santa Barbara, CA. 93103; [2]Department of Ecology and Evolutionary Biology, University California Los Angeles, Los Angeles, CA. 90095-1606.

Recent proposals for restoration at Ballona increase tidal habitat relative to the 19th century. Historic data suggest that most of the habitat at Ballona was seasonally wetted and episodically flooded by fresh water trapped behind the beach berm and dune line. This isolation from the sea combined with,

infrequent winter episodes of tidal exchange produced a range of variably fresh to brackish wetlands with seasonal aspect. Reconstruction of past conditions may not be the only management objective, and is likely difficult in this urban setting. However, history and comparison also inform us about coastal processes. And, departures from historical landscapes such as opening of estuaries and lagoons often yield unexpected outcomes frequently resulting in unanticipated expenses to maintain restoration designs. In addition, the current, artificial flood control channel provides environmental and social services in addition to flood control, that will be eliminated in current restoration plan, and would have to be mitigated through other actions. We discuss these points, and offer some alternative designs. These may require active management, but should achieve habitats more similar to 19th century conditions, with more heterogeneity and greater benefit to wildlife – potentially at lower cost, with less disruption to current uses, lower likelihood unanticipated consequences, and greater facility to respond to circumstances. Opening of lagoons to the sea results in sedimentation in the form of flood tide deltas of beach sand that require costly and carbon intensive dredging to remove. The need for such dredging has been conspicuously underestimated in the restoration of Bolsa Chica and Batiquitos. Historically Ballona also suffered flood tide delta formation following lagoon opening, and such sedimentation can be seen to operate today despite ongoing dredging and the presence of jettys to limit sediment accumulation. Current designs without further mitigation in terms of still more dredging will yield tidal deposition of material from the beach. Even without added sediment reworking of material in the planned estuary will generate internal delta features where tidal flow decelerates, rapidly filling lateral channels and impacting the tidal nature of the system. Stream flooding will also rework the sediment in the planned estuary rapidly modifying the landscape in ways that are difficult to predict. The current hydraulic flood channel, although unnatural, permits by-pass and export of sediment from the system during high stream flow. This replaces some aspects of the sediment export "scour" function of flood-flow in California estuaries. The hydraulic channel also allows the bypass of "first flush" contaminants that would otherwise enter the marsh after the initial rainfall on the urban watershed. Active management of flows while using the current channel for bypass of sediments and contaminants would limit sediment infill, contamination and eutrophication of marsh habitats. In addition, the channel has been the site of crew races since the 1940s, and it levees provide access for vector control and first responders, which will be more limited and difficult in current designs. Alternatives that require less alteration of the current landscape can provide significant habitat benefits without the loss of these functions.

11. HISTORICAL CONDITION OF BALLONA ESTUARY. HOW OPEN IS OPEN? HOW CLOSED IS CLOSED?

Eric D. Stein[1], David K. Jacobs[2], Travis Longcore[3], and Shawna Dark[4]. [1]Southern California Coastal Water Research Project; [2]UCLA Department of Ecology and Evolutionary Biology; [3]University of Southern California - Spatial Sciences Institute; [4]California State University, Northridge.

Determining the appropriate design template is critical to coastal wetland restoration. In seasonally wet and semi-arid regions of the world coastal wetlands tend to close off from the sea seasonally or episodically, and decisions regarding estuarine mouth closure have far reaching implications for cost, management, and ultimate success of coastal wetland restoration. To help inform restoration decisions, we developed a conceptual model that classifies estuarine mouth closure patterns using information on geologic origin, exposure to littoral process, and watershed size and runoff characteristics. Model output is then validated by review of historical maps and photographs. Application of the classification model suggests that under natural conditions, the vast majority of California estuaries experience some degree of closure, and most spend a preponderance of time completely isolated from the sea or with a limited or muted tidal connection. In this state, stream flow rather than tidal influence is the most critical variable controlling mouth opening. The distribution of closure states for an estuary over time can be used to guide management decisions based on dominant closure and hydrodynamics of the system. In the case of the Ballona Estuary, migration of the Los Angeles River resulted in a system that was predominantly closed to the tides and supported a vast expanse of diverse salt marsh and alkaline marsh and flat habitat. This knowledge can be used to help determine appropriate habitats to consider during the restoration planning process.

12. BALLONA WETLANDS RESTORATION: RECREATING ESTUARINE HABITATS IN LOS ANGELES

Diana Hurlbert. Santa Monica Bay Restoration Commission, Los Angeles, CA.

In 2004, the State of California took title to 600-acres of the remaining Ballona Wetlands in Los Angeles. The property is owned by two state agencies, the Department of Fish and Game and the State Lands Commission. The Coastal Conservancy is funding the restoration planning. Together, the three agencies are working with stakeholders and other agencies to develop a plan for restoration of this extraordinary resource in the middle of Los Angeles. The agencies and stakeholders have established restoration goals, which include: 1) Restore and enhance salt-water influenced wetland habitats to benefit migratory shorebirds, waterfowl, seabirds, and coastal fish and aquatic species; 2) Provide for wildlife-dependent public access and recreation opportunities compatible with the habitats, fish and wildlife conservation; 3) Identify and implement a cost-effective, ecologically beneficial, and sustainable (low maintenance) habitat restoration alternative. Five preliminary alternatives which meet these objectives were developed and refined by the Project Management Team and consultant team in a Feasibility Report, with the advice of stakeholders and agencies. The proposed restoration plan includes a diverse mix of estuarine and upland habitats that meet regional habitat needs and are resilient to projected climate change and sea-level rise. The Ballona Wetlands Restoration planning process and supporting technical studies will be presented as a case study of tidal wetland restoration in a highly-urbanized environment with accelerated future sea-level rise.

13. THE EMERALD NECKLACE AS A REGIONAL CASE STUDY FOR LANDSCAPE SCALE CONSERVATION – OPPORTUNITIES TO ENHANCE WILDLIFE HABITAT FOR BENEFIT OF URBAN RESIDENTS IN PUBLIC PARKS

C. Robinson. Amigos de los Rios – the Emerald Necklace Group, Altadena, CA, 91001. 91001.

Amigos de los Ríos – The Emerald Necklace Group, is committed to designing quality public environments that revitalize urban neighborhoods within economically disadvantaged Southern Californian communities. Since 2004 we have worked outline & implement a regional green infrastructure network for landscape scale conservation. Our mission is to create an Emerald Necklace of sustainable open spaces through out the "asphalt quilt" of East Los Angeles County along the urban river corridors that connect the San Gabriel Mountains to the ocean: protecting the environment, strengthening community life and providing opportunities to enhance wildlife habitat for the benefit of current and future generations. Amigos de los Rios has developed a new vocabulary or "DNA" for award winning public parks based on sustainable design principles, use indigenous materials, native plant landscapes that foster biodiversity & creation of cultural interpretive areas to reconnect urban residents of all ages to local habitat. Our projects provide "stepping stones". Our driving design principles promote biodiversity. We will highlight several case study parks that promote survival of native bird, butterfly and lizard species. Our park projects are at the nexus between natural & cultural history. We believe natural areas and the ecological functions and services they perform for humanity cost much less than those that we can engineer. Rich soil, clean air, fresh water and/or biodiversity provide "Natural Capital" not conventionally thought of in accounting practices -, i.e. offsetting ecosystem degradation. The next generation of stewards will come from our urban communities who have benefited from the Emerald Necklace.

14. INTRODUCTION TO THE WATERSHED AND VEGETATION MAPPING, WILDLIFE USE AND RECREATION OPPORTUNITITES ALONG THE SAN GABRIEL RIVER SYSTEM

Ellen Mackey and Blake Whittington. Metropolitan Water District of Southern California and the Council for Watershed Health, Los Angeles, CA 90012.

Los Angeles basin rivers have lost most of their natural character. Single-purpose flood control structures throughout the LA basin restrict ecosystem function. Little remains of the historic riparian vegetation and wildlife. Despite restoration efforts, much of the system will remain concreted for many

years. However, the rights-of-way (ROW) along the channels can be viewed both as valuable wildlife corridors to link isolated wildlands within the urban matrix to the upper watershed's protected lands, and provide valuable acreage for linear parkways in park-poor cities. The Los Angeles County Department of Public Works published the *Landscaping Guidelines and Plant Palettes* for the Los Angeles River to expedite design plans and plant choices for projects within the ROW. We have visited and recorded information along the ROW throughout the San Gabriel River system. We photographed and mapped vegetation, recreation opportunities, homeless encampments, and wildlife use signs. We used a handheld Trimble GPS unit and GPS Photo-Link software to display photographs, aerial photographs' positions, and field notes on a searchable website. Upper watershed areas contained most of the intact native vegetation while the rights-of-way along the concreted main stem and major tributaries were essentially devoid of vegetation. However, despite the barrenness, opportunistic species, such as coyote, raccoons, deer, and numerous bird species, use the rights-of-way as linkages between open space islands. Photographic evidence for wildlife use includes: scat, droppings, dust baths, and tracks. Biological resources conspicuously absent include: reptiles, amphibians, and most insects. Once linear parkways are contiguous, wildlife use could expand.

15. HERPTOFAUNA AND HABITATS OF THE LOWER SAN GABRIEL RIVER

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Along the San Gabriel River the Santa Fe Dam basin, including a protected wildlife area of alluvial scrub vegetation, supports a fairly diverse herptofauna, by virtue of its geographic location at the base of the San Gabriel Mountains and fairly undisturbed habitat. The open spaces between native shrub cover supports low annuals and few stands of invasive grasses and forbs, allowing for populations of Coast Horned Lizard (*Phrynosoma coronatum*), Coastal Whiptail (*Aspidoscelis tigris stejnegeri*) and other reptiles. Whittier Narrows Dam basin, approximately 8 miles downstream from Santa Fe Dam, is more impacted by recreational land uses and more dense invasive grasses and herbaceous cover. This yields a depauperate herpetofauna by comparison. Several species drop out here (e.g. Coast Horned Lizard and Coastal Whiptail), although there is still a localized population of Red Racer (*Coluber flagellum piceus*). The Puente Hills to the east of Whittier Narrows has been surveyed more systematically for herpetofauna and, as an upland series of hills, retains some species now rare or absent from the lowland San Gabriel River corridor [Arboreal Salamander (*Aneides* lugubris), Western Spadefoot (*Spea hammondii*), Western Blind Snake (*Leptotyphlops humilis*)]. Widespread and ubiquitous species (Western Fence Lizard (*Sceloporus occidentalis*), Southern Alligator Lizard (*Elgaria mulitcarinata*) and San Diego Gopher Snake (*Pituophis catenifer*) occur in all three sites.

16. NATIVE SEED PALETTES FROM THE ANGELES NATIONAL FOREST

K.R. VinZant. U.S. Forest Service, Angeles National Forest, Arcadia, CA, 91006.

A wide range of restoration projects across the Angeles National Forest has led to the recent development of native seed palettes for many different vegetation types. These vegetation types range from alluvial fan scrub, coastal sage scrub, mixed chaparral, oak woodland, and assorted riparian vegetation complexes. The determination of plant species to be included in the restoration palette is based on a variety of factors such as commonality/dominance, reproduction methods and rates, growth habit, drought, sunlight, and disturbance tolerance, soil preference, and wildlife habitat requirements. Other aspects that must be considered are the availability, ease in collection, and storage life of the native seed to be harvested and the associated cost to collect, clean, test, and store this seed. After taking all these attributes into consideration, a native plant palette with a listing of anywhere from ten to forty species is generated for restoration use.

17. WILDLIFE IN THE PUENTE HILLS PRESERVE

S.D. Lucas. Ecologist, Puente Hills Habitat Preservation Authority, Whittier, CA, 90602.

The Puente Hills represents one of the largest areas of remaining intact habitat in the San Gabriel River Watershed, and is part of the Puente-Chino Hills Wildlife Corridor which is widely recognized as important for wildlife movement and habitat connectivity south to the Santa Ana Mountains. Despite

being surrounded by extensive urban development, and being fragmented by several large roadways, the Puente Hills support a high diversity of wildlife species and a fully-functional ecosystem with all trophic levels represented. Numerous studies have documented more than 200 different wildlife species in the Puente Hills, ranging from dragonflies to mountain lions, of which at least 30 are sensitive species. Medium and large mammal movements through this Corridor has been the focus of several studies which highlight the importance of removing barriers to, and preserving opportunities for, animal movement and dispersal. Roadway underpasses are critical to successful wildlife movement across high-volume roads which can act as barriers, but the location and characteristics of these underpasses is also critical to their functionality. Other factors influencing movement and connectivity may include human activity and habitat quality. Securing remaining private lands in the corridor through acquisition will also promote the long-term function and viability of the Puente-Chino Hills Wildlife Corridor.

18. DESIGNING FOR THE RESTORATION OF COMPLEX HABITATS AND BIOTIC CONNECTIONS WITHIN AN URBAN SOUTHERN CALIFORNIA LANDSCAPE: LESSONS LEARNED WHILE WORKING ON THE TRANSFORMATION OF A MILITARY BASE TO PUBLIC PARK

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Over 500 hectares of a military air station in southern California has been made available to become a high biodiversity public facility, the Orange County Great Park. The park is to have many functions including cultural, athletic, educational, social, and natural habitat spaces. Much of the park's natural landscape will be restored into a complex Mediterranean biome, including sage scrub, oak woodlands, riparian communities, and grasslands. One natural stream that has been buried beneath the airfield for 60 years will be day-lighted. The last three-miles of a regional wildlife corridor will be completed to connect existing nature reserves in coastal hills and inland mountains, allowing for the movement of animals and seeds through the region. Design of the park was by a collaboration among ecologists, landscape architects, civil and structural engineers, hydrologists, and architects, all who were charged with making an ecologically sustainable landscape embedded in a large urban area. Lessons learned while working collaboratively on design of the ecological infrastructure of the park can be applied to advancing similar efforts to restore aquatic and upland habitats for native animal species in other urban areas of southern California.

19. IDENTIFICATION OF FOCAL WILDLIFE SPECIES FOR RESTORATION, COYOTE CREEK WATERSHED MASTER PLAN

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I worked with conservation ecologist Verna Jigour to identify suites of wildlife species – butterflies, fish, amphibians, reptiles, and birds – that could serve as indicators of successful restoration of freshwater aquatic, riparian woodland, oak/walnut woodland, alluvial scrub, and coastal sage scrub, within this predominantly urbanized watershed. The master plan and technical appendices are available at http://www.rmc.ca.gov/plans/water.html. Our aims were to ensure that restorative actions would be aimed toward establishing actual wildlife habitats, which are species-specific, and to provide benchmarks for evaluating the success of habitat establishment over time (1–7 years; 8–25 years; and >25 years). We tried to be realistic in our selection of focal species, taking into account (a) ecological limitations posed by large-scale urbanization of the Coyote Creek watershed, and (b) restrictions on habitat development likely to be imposed by agencies charged with flood control, fire, and vector control. We were nevertheless ambitious, identifying various rare and declining species with specific habitat needs. Some focal species are targeted for urban areas and others for more natural areas. We identified Chino Hills State Park as an ecological reference site to help guide future habitat restoration efforts. The park hosts populations of most of the focal wildlife species, and can serve additional reference needs for habitat restoration, as well as being a likely source for recolonization by various wildlife species. It is yet to be seen whether the "visions" of ecologists and those of landscape architects and governmental agencies can be unified and eventually manifested through this planning process.

20. HISTORIC ECOLOGY AS A TOOL FOR INFORMING RESTORATION PLANNING IN THE SAN GABRIEL WATERSHED

Eric D. Stein[1], Shawna Dark[2], Travis Longcore[3], Robin Grossinger[4], and Jason Casanova[5]. [1]Southern California Coastal Water Research Project; [2]California State University Northridge; [3]University of Southern California; [4]San Francisco Estuary Institute; [5]Los Angeles and San Gabriel Rivers Watershed Council.

Historical wetland losses are often cited as a motivation for prioritizing wetland restoration. Historical ecology is a valuable tool that can help inform restoration planning by helping us understand the mechanisms of past decline, providing templates for future restoration, and serving as context for making decisions about resource allocation. The utility of historical ecological analysis is illustrated for the San Gabriel River to assess wetland losses since ca. 1850 and to identify current restoration opportunities. Numerous data sources were used to gain insight into historical wetland and riparian habitats, including Mexican land grant sketches, US General Land Office maps, irrigation maps, topographic maps and soil surveys, and 1920's aerial photographs. Secondary data sources included oral histories, ground photographs, field notes, and herbaria records. Data sources were digitized, georeferenced, and overlaid in GIS to produce historical wetland polygons. Polygons were attributed for data sources, classified using the National Wetland Inventory system to facilitate comparison with contemporary conditions, and assigned a confidence rating based on the certainty in the primary data sources. Concordance between multiple data sources supported inferences about historical condition. Results of the analysis revealed that up to 86% of historic wetlands have been lost; the greatest losses are the near total elimination of extensive alkali flats and seasonal wetlands that once dominated the lower river floodplain. Despite the dramatic wetland losses, several opportunities exist for wetland restoration where remnant wetlands and/or wetland signatures exist.

21. LANDSCAPE CHANGES WITHIN THE SAN GABRIEL RIVER WATERSHED: WHICH SNAKE SPECIES ARE KEEPING PACE AND WHICH ONES ARE NOT (OR CANNOT)

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The San Gabriel River watershed of southern coastal California is located within the California Floristic Province, which has been identified as a global biodiversity hotspot. Although the San Gabriel River watershed represents only 0.5% of area within the province it supports high biodiversity in its own right. The watershed ranges from sea level up to 10,068 ft (3,069 m) at the peak of Mount San Antonio. The watershed supports a wide range of generalized vegetation communities including salt marsh, coastal prairie, freshwater marsh, coastal sage scrub, valley grassland, riparian woodland, valley and foothill woodland, oak woodland, chaparral, conifer forest, montane meadow, and subalpine forest. A high diversity of snake species occur within the various habitats within these vegetation communities. I will discuss why some snake species within the San Gabriel River watershed are more at risk of extirpation due to habitat destruction than others. Patterns were revealed by analyzing the snake community in terms of affinity to soil moisture levels and behavioral guilds.

22. BIOTA OF LOS CERRITOS WETLANDS: AN URBANIZED ECOSYSTEM

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The San Gabriel River watershed culminates at Los Cerritos Wetlands, just before flowing into the Pacific Ocean. This estuarine environment of the San Gabriel River represents an interface between the riverine, marine, and terrestrial realms. Historically, multiple habitat types intergraded at this once 2400 acre coastal wetlands system including coastal salt marsh, riparian woodlands, coastal sage scrub, coastal strand, and subtidal marine. However, this ecosystem has been altered over the past century and become ever more complex with overlays of urban infrastructure such as flood control facilities, power generating plants, oil operations, roadways, and other developments. The biota that persists in these urbanized wetlands remains diverse, yet understudied, since much of this land still is privately owned. Cataloguing the habitats and associated floral and faunal species throughout the remaining 500 acres of Los Cerritos

Wetlands has just begun as part of an effort to complete a conceptual restoration plan for the area. Thus far, 11 habitat types have been identified that host 63 species of native plants. Furthermore, 123 bird species, 11 mammal species, 7 fish species, and a variety of reptiles, amphibians and invertebrates have been documented. Lastly, critical habitat for special status plants and animals is present including the endangered Belding's savannah sparrow, California least tern, and Pacific green sea turtle. Understanding the existing biota of Los Cerritos will properly inform the future restoration of the San Gabriel River's estuary.

23. FRESHWATER FISHES OF THE SAN GABRIEL RIVER, SOUTHERN CALIFORNIA

Jonathan N. Baskin, Thomas R. Haglund, and Steven H. Bryant. California State Polytechnic University Pomona, Biological Sciences Dept. Pomona, CA 91768 and San Marino Environmental Associates, 560 South Greenwood Ave. San Marino, Ca 91108.

Four extent species of native strictly freshwater fishes are described with comments on their habitat. These are the Santa Ana sucker (*Catostomus santaanae*) a federally listed Threatened Species, Santa Ana speckled dace (*Rhinichthyes osculus*) a state Species of Special Concern, arroyo chub (*Gila orcutti*) a state Species of Special Concern, and the anadromus rainbow trout/southern steelhead (*Oncorhynchus mykiss*) a federally listed Endangered Species. The results of a habitat selectivity study are given for two of these, the sucker and the dace. Three native freshwater species have been extirpated, the unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), the Pacific lamprey (*Lampetra tridentata*) and the Pacific brook lamprey (*Lampetra* cf. *pacifica*). Twenty species of non-native fishes have been introduced. These include mosquito fish (*Gambusia affinis*), inland silverside (*Menidia* beryllina), Mozambique tilapia (*Oreochromis mossambicus*), largemouth bass (*Micropterus salmoides*), small mouth bass (*Micropterus dolomieu*), redear sunfish (*Lepomis microlophus*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), black carppie (*Pomoxis nigromaculatus*), threadfin shad (*Dorosoma petenense*), common carp (Cyprinus carpio), goldfish (*Carassius auratus*), fathead minnow (*Pimephales promelas*), red shiner (*Cyprinella lutrensis*), black bullhead (*Ameiurus melas*), brown bullhead (*Ameiurus nebulosus*), yellow bullhead (*Ameiurus natalis*), white catfish (*Ameiurus catus*), channel catfish (*Ictalurus punctatus*), blue catfish (*Ictalurus furcatus*).

24. SOUTHERN CALIFORNIA STEELHEAD RECOVERY PLAN: A ROADMAP TO RECOVERY

Mark H. Capelli. South-Central/Southern California Steelhead Recovery Coordinator, National Marine Fisheries Service 735 State Street, Suite 616, Santa Barbara, CA 93010.

In 1997 the National Marine Fisheries Services (NOAA Fisheries) listed a Distinct Population Segment (DPS) of steelhead (*Oncorhynchus mykiss*) within southern California, from the Santa Maria River to Malibu Creek, as endangered. In 2002 a range extension of the Southern California Steelhead DPS was extended to the U.S.-Mexico border.

NOAA Fisheries Science Center and a Technical Recovery Team has characterized the historic populations of steelhead and developed viability criteria for the recovery of this DPS. The TRT developed several basic finding regarding the nature of the southern California populations of native *O. mykiss*: 1) pre-historic distribution of *O. mykiss* was widespread throughout the coastal drainages; 2) current distribution of *O. mykiss* is still wide spread (with the anadromous forms the most constricted); 3) anadromous runs *O. mykiss* have been eliminated or depressed in about one-third of the historically occupied watersheds; 4) remaining occupied watersheds exhibit extremely depressed anadromous *O. mykiss* populations; *O. mykiss* above artificial barriers are most closely related to below barrier populations of *O. mykiss*; O. mykiss above artificial barriers are residualized decedents of anadromous *O. mykiss* runs, not planted, hatchery reared *O. mykiss*; 5) *O. mykiss* above artificial barriers are an integral component of the anadromous *O. mykiss* populations; and 6) *O. mykiss* populations above artificial barriers have the potential to resume an anadromous life cycle. Population and DPS viability criteria must address issues such as specific mean annual run size of individual populations; ocean cycles affecting marine survival and growth; spawner density; the anadromous and non-anadromous fraction of an *O. mykiss* population complex; the number of populations per biogeographic group; protection of drought

refugia; geographic separation of populations within biogeographic regions; and preservation of life-history diversity (fluvial anadromous, freshwater resident, lagoon anadromous).

NMFS Technical Recovery Team for Southern steelhead has divided the Southern California Steelhead DPSs into five Biogeographic Population Groups, characterized by a distinguishing suite of physical, climatic and hydrologic features. Recovery of the Southern California Steelhead DPSs will require the restoration of a minimum number of populations within each of the five Biogeographic Population Groups. The core watersheds identified in this biological strategy are geographically dispersed across the recovery planning area (extending from the Santa Maria River to the U.S.-Mexico Border) to preserve the existing diversity of life-history forms (ranging from anadromous to resident) and their evolutionary trajectories. Additionally this biological strategy is intended to minimize the likelihood of extirpation of individual populations within each Biogeographic Population Group as a result of natural perturbations (ranging from periodic drought and wildfires to longer range climatic changes), and preserve the potential natural dispersal of fishes between watersheds.

The San Gabriel River is one of three major watersheds that comprise the Monte Arido Biogeographic Population Group, and is identified as a Core 1 Population for the purposes of focusing recovery actions on watersheds essential to meet the DPS-wide viability criteria identified by the Technical Recovery Team.

The Recovery Plan for the Southern California Steelhead DPS identifies a series of recovery actions intended to address the threats currently facing the species, as well as future threats posed by climate changes, and related habitat transformations. The two most prominent threats are restriction of access to upstream spawning and rearing habitats as a result of physical blockages (dams, road crossings, *etc.*), and the modification of the natural seasonal pattern of flows necessary to support migration, spawning, and rearing during the freshwater phase of the *O. mykiss* life cycle. Loss of estuarine habitats and periodic poor ocean conditions also contribute to the decrease in the productivity of *O. mykiss.*

The critical Recovery Action identified for the San Gabriel River in the Southern California Steelhead Recovery Plan addresses both of these threats: Implement operating criteria to ensure the pattern and magnitude of groundwater extractions and water releases from Morris, San Gabriel, and Cogswell dams provide the essential habitat functions to support the life history and habitat requirements of adult and juvenile steelhead. Physically modify Morris, San Gabriel, Cogswell, and Santa Fe dams, and road, highway, and railway crossings to allow natural rates of migration of steelhead to upstream spawning and rearing habitats, and passage of smolts and kelts downstream to the estuary and ocean

A long-term research and monitoring program is proposed to address a number of key issues and uncertainties (such as the relationship between anadromous and resident forms, inter-basinal dispersal rates, spawning density, *etc.*) and refine the population and DPS viability criteria developed by the TRT.

Steelhead recovery in Southern California will take place in a landscape which has been highly modified, and currently occupied by over 22 million people. Recovery will require re-integrating the listed sub-populations back into habitats in a manner which allows the co-occupancy of watersheds by both fish and people.

25. THE STATE OF THE SAN GABRIEL RIVER WATERSHED: 2005-PRESENT

Kristy Morris[1] and Scott Johnson[2]. [1]Council for Watershed Health, 700 N Alameda St, Los Angeles, CA; [2]Aquatic Bioassay & Consulting Laboratories, Inc., Ventura, CA.

The San Gabriel River Regional Monitoring Program (SGRRMP) was the first watershed-wide monitoring effort initiated in California combining a multilevel, probabilistic (ambient) monitoring design with targeted sampling. SGRRMP is designed to answer five key monitoring questions: What is the ambient condition of streams?; Are conditions at unique habitats changing over time?; What are water quality conditions near major discharges?; Is it safe to swim?; and, Is it safe to eat fish? Sampling for these programs has included seven annual summer surveys that commenced in 2005. To date, SGRRMP has collected and analyzed samples from 90 probabilistic sites, nearly 100 unique habitat sites, 800 samples for fecal indicator bacteria (FIB), and over 200 fish tissue samples.

The overall condition of streams in the watershed is based on a probabilistic monitoring design using a combination of indicators that include water quality, toxicity, bioassessment, and physical habitat parameters. The California rapid assessment method (CRAM) was used to assess changes in habitats of unique interest. The water quality conditions in receiving waters near seven major NPDES discharges was assessed by comparing monitoring data against state and federal standards. Fecal indicator bacteria (FIB) were collected during summer months at popular lake and river recreation areas to assess swim safety. Fish

consumption safety was assessed by measuring the concentrations of mercury, selenium, DDT and PCB in tissues from fish collected at popular angling sites.

Results to date illustrate clear patterns in stream condition that distinguish the upper (un-developed) portions and lower (developed) portions of the watershed in terms of water quality and habitat condition stressors. There have been few exceedances of water quality standards in receiving waters near NPDES discharges during the period. Public swimming areas have had few exceedances of FIB standards. Contaminant concentrations in fish tissues have helped identify species that exceed state consumption thresholds and will be used by the state to determine where fish advisory postings might be needed. These results have been presented to watershed managers, regulators, the public, politicians and the media through a State of the Watershed report and symposium, annual summary reports and a web based data portal.

26. CHARACTERIZING BIOLOGICAL INTEGRITY USING BENTHIC MACROINVERTBRATE COMMUNITIES AS INDICATORS WITHIN THE SAN GABRIEL RIVER WATERSHED

W.L. Willis[1], S.C. Johnson[1], and K. Morris[2]. [1]Aquatic Bioassay and Consulting Laboratories, Inc., Ventura, CA, 93001; [2]Council for Watershed Health, Los Angeles, CA, 90012.

The health of stream ecosystems is summarized by the river continuum concept which describes the predictable flow of energy, in the form of organic material, from watershed headwaters to the larger order streams and rivers of the lower watershed, and the corresponding succession of microbial, algal and benthic macroinvertebrate (BMIs) communities along this continuum. Disruption of this stream continuum through anthropogenic inputs and/or physical habit disturbances can be detected by biological community indicators. The SGRRMP has collected BMI, chemical, physical habitat and toxicity testing data from 2005 to 2011 using a multiple lines of evidence approach to determine stream health. This presentation focuses on the changes in the biological community dynamics of the San Gabriel River Watershed using BMIs as indicators of pollution. The Southern California Index of Biological Integrity (IBI) is based seven biological metrics and was developed using reference conditions found throughout the southern California region. The IBI and its component metrics are used to quantify the biological condition of streams in the San Gabriel watershed and to assess the magnitude of potential stressors on these communities. Streams located in the higher elevations near the headwaters of the San Gabriel River have BMI communities that are similar to reference conditions and thus have a higher IBI scores than those in the more highly urbanized lower watershed. The composition of the BMI community follows a predictable stressor gradient that is most clearly defined by physical habitat disruption associated urban development and actively managed flood control which has severely disrupted the hydrology of the watershed. These changes have reduced streambed habitat complexity and the integrity of the riparian zones which are both important to the integrity of BMI communities. Identifying these sources of stress using BMIs is helping watershed managers to focus and prioritize their restoration efforts.

27. CAN RANID FROGS BE RESTORED TO THE SAN GABRIEL WATERSHED?

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Historically, three Ranid frog (true frogs) species occupied the San Gabriel watershed; the California red-legged frog, the foothill yellow-legged frog, and the Sierra Madre yellow-legged frog. By 1970, both the California red-legged frog and the foothill yellow-legged frog had been extirpated from the San Gabriel watershed. Currently, the only remaining species within the San Gabriel watershed is the Sierra Madre yellow-legged frog. Since the early 1970s, the Sierra Madre yellow-legged frog has declined precipitously in southern California. In concern for this species, a working group was formed in 2000 to develop a framework for conservation and recovery of the species. At a single, Bd positive site in the San Gabriel Mountains, two priority restoration actions were identified and implemented by the working group; non-native trout removal and limited recreational use through temporary forest closures. With 12 years of monitoring at the site before and after the restoration efforts, we found that frogs responded to the removal of non-native trout by re-occupying newly fishless habitat over three years. Unlike the time lag

with fish removal, the frogs responded to reduced recreation immediately and showed an 875% increase of the mean number of adult frogs detected/survey over five years.

28. TURTLE SOUP - AN ENDANGERED SPECIES IN THE SAN GABRIEL RIVER

D. Lawson. National Marine Fisheries Service, Southwest Region, Protected Resource Division, Long Beach, CA, 90802.

The presence of green sea turtles (*Chelonia mydas*) has been occasionally recorded in inland waterways and the coastal region near Long Beach, California since at least the 1980s. Periodic sightings and strandings of this species in the area were generally considered a reflection of ephemeral foraging visits by transient individual animals. Beginning in 2008, the National Marine Fisheries Service office in Long Beach initiated more dedicated efforts to study sea turtles in the San Gabriel River, as their presence appears to be more regular and consistent than previously known. A specific area of interest includes a stretch of the San Gabriel River located approximately 1.5 miles inland and adjacent to two coastal power plant facilities. Numerous observations collected by several individuals from 2008–2010 suggest that green sea turtle presence in the San Gabriel River is persistent year-round. Additional reports also suggest that other local areas may be visited occasionally by sea turtles. In combination, the available information is beginning to indicate that the Long Beach area may be supporting significant numbers of green sea turtles, widely ranging in size, and that this area may serve as more important habitat for green sea turtles in southern California than was previously understood. This talk will relay the developing story of green sea turtles in the Long Beach area, highlighting the exciting research and conservation opportunities that lie ahead regarding this rather surprising situation.

29. ENGINEERING SOLUTIONS TO REDUCE BYCATCH IN U.S. FISHERIES

L. Enriquez. National Marine Fisheries Service, Long Beach, CA, 90802.

In the process of fishing, species that are not the target of the fishery are often caught. These species are considered bycatch whether released (dead or alive), kept, or even if there are unobserved encounters (mortalities) when the animals interact with fishing gear. The U.S. National Marine Fisheries Service (NMFS) runs the Bycatch Reduction Engineering Program (BREP) that aims to develop technology and modified fishing practices that minimize bycatch of all types of fish species, sponges and corals, marine mammals, seabirds, and sea turtles. BREP also aims to minimize injury and prevent mortality when animals are released alive. The BREP started in 2007 as an internal program for NMFS commercial and recreational fishing experiments, primarily. BREP also contributed funds to the World Wildlife Fund's Smart Gear Initiative. Examples of past BREP-funded projects include: testing fish and sea turtle excluder devices in trawl fisheries, evaluating weak-hook technology in longline fisheries, and assessing post-release mortality of the common thresher shark (*Alopias vulpinus*) in a recreational fishery. In 2012, the BREP also started funding competitive grants for non-federal researchers.

30. A RISK ASSESSMENT FRAMEWORK FOR CHANNEL ISLANDS NATIONAL MARINE SANCTUARY

Mindi Sheer. NOAA Fisheries.

The California Current Integrated Ecosystem Assessment, or IEA, is a quantitative analysis of natural and socioeconomic factors, with respect to ecosystem management objectives affecting California Current marine and coastal resources. The IEA is a five-step process. One of these steps is evaluating the risk to ecosystem indicators by human activities (Levin et al 2009). We are currently conducting an ecosystem-based risk assessment (RA) for the Channel Islands National Marine Sanctuary. This RA is based on a framework in Samhouri and Levin (2011), and is designed to quantify the risk that specific human activities or pressures will lead to negative effects on marine and coastal ecosystem components. Results from RAs have potential for planning, prioritizing management actions, stakeholder engagement, and incorporating both peer-reviewed and expert-opinion information. We estimated the relative level of risk to various ecosystem components by determining the Exposure (E) of habitats (e.g. kelp forest, intertidal

zone, surfgrass, pelagic, soft and hard bottom subtidal) and representative species (e.g., red abalone, *Haliotis rufescens*, California sheephead, *Semicossyphus pulcher*, brown pelican *Pelecanus occidentalis californicus* humpback whale *Megaptera novaeangliae*) to stressors associated with human activities (e.g., fishing, oil and gas development, dredging, shipping), and the susceptibility or Sensitivity (S) of habitats and species to the stressor. We will present the RA framework and some initial results.

31. TESTING DEEP-SET BUOY GEAR TO REDUCE BYCATCH IN THE U.S. WEST COAST SWORDFISH FISHERY

C. Heberer[1], C. Sepulveda[2], and S. Aalbers[2]. [1]National Marine Fisheries Service, 6010 Hidden Valley Rd., Carlsbad, CA., 92011; [2]Pfleger Institute of Environmental Research, 315 N. Clementine, Oceanside, CA., 92054.

Gear interactions and incidental take of non-target species is playing an increasing role in the regulation and management of commercial fisheries on the local, regional, and global level. U.S. West coast fisheries targeting swordfish, *Xiphias gladius*, face a range of management measures aimed to reduce bycatch including expansive time/area closures and mandatory gear and operational modifications. These measures have been successful in reducing interactions with bycatch species of concern, most notably the leatherback sea turtle, *Dermochelys coriacea*, but have come at a heavy cost in regards to decreased domestic supply of swordfish and declining participation and revenue for existing fishing fleets. The economic consequences of this management regime have negatively impacted interdependent businesses and communities. Current research into swordfish and leatherback sea turtle habitat use demonstrates the potential for species segregation within distinct vertical habitat zones. This information is currently being used to develop and trial alternative gear types that may lead to future management strategies to reduce bycatch interactions. This presentation will discuss on-going research to test an alternative low-impact swordfish gear designed to avoid bycatch species of concern.

32. INNOVATION IN BOTTOM TRAWLING: THE NEW LIGHT-TOUCH TRAWL NET

Capt. Mike McCorkle. President, Southern California Trawlers Association, 6 Harbor Way Box 101, Santa Barbara, CA, 93109.

Trawling has become a four-letter word for some, due to bycatch and seafloor habitat issues. Over the last two decades, members of our Association have refined our nets to minimize both bycatch and potential impacts on the seafloor. The light-touch trawl net is made of floating poly webbing, light footrope and drop-loop chain and as a result will work with much smaller trawl doors. The California Fish and Game Commission directed the Department of Fish and Game to work collaboratively with Sea Grant and our Association members to collect information on how this net works in order to determine whether or not to allow continued trawling in designated halibut trawl grounds. From the results of these studies, the Commission found that these nets 1) minimizes bycatch, 2) is likely not damaging seafloor habitat, 3) is not adversely affecting ecosystem health, and 4) is not impeding reasonable restoration of kelp, coral, or other biogenic habitats. Video of this net in action will be shown.

33. THE HISTORY AND SUSTAINABILITY OF THE CALIFORNIA PACIFIC SARDINE (*SARDINOPS SAGAX*) FISHERY

Mandy L. Lewis. California Department of Fish and Game, Marine Region, Los Alamitos, CA, 90720.

The commercial purse seine fishery for Pacific sardine (*Sardinops sagax*) in California has a long and well-documented history beginning in 1916. Over the last century this fishery has experienced expansions and contractions, due to both oceanographic conditions and fishing pressure. Currently this is one of the largest and most valuable fisheries in the state. It is managed using a limited entry (LE) permit system and an annual harvest guideline (HG) that is divided into three seasonal allocations, under the authority of the Pacific Fishery Management Council (PFMC) and the Coastal Pelagic Species Federal Management Plan (FMP). In 2008 the fishery experienced a significant decrease in the harvest guideline due to a decline in the

annual biomass estimate. This decrease has resulted in changes to the dynamics of the fishery and fishery-dependent data collection. As a result, both the industry and managers are looking at new ways of management and data collection.

34. 2010 FISHERY REVIEW OF WHITE SEABASS, *ATRACTOSCION NOBILIS*

V.B. Taylor. California Department of Fish and Game, Marine Region, Los Alamitos, CA, 90720.

White seabass is an important commercial and recreational species in California. A decrease in both commercial and recreational catch led to the implementation of several important regulations as well as legislation designed to enhance the wild population. Both commercial and recreational fisheries have a seasonal closure during the white seabass spawning season, as well as bag and size limits. White seabass is also the focus of The Ocean Resources Enhancement and Hatchery Program (OREHP), which is an experimental hatchery program to determine if the culture of marine finfish is feasible. The OREHP releases up to 350,000 juvenile fish annually for enhancement purposes and is managed by the Department of Fish and Game. The White Seabass Enhancement Plan provides a framework for managing the OREHP in a sustainable manner. In addition, the White Seabass Fishery Management Plan requires annual monitoring and assessment of the fisheries.

35. THE STATUS OF THE CALIFORNIA SEA CUCUMBER FISHERY

D.M. Stein and C. Mireles. California Department of Fish and Game, Santa Barbara, CA, 93109.

In California, both the warty sea cucumber (*Parastichopus parvimensis*) and the giant red sea cucumber (*P. californicus*) have increasingly become more important commercially landed invertebrate species. Their value has increased substantially over the last decade, with the mean unit sale price per pound doubling between 2010 and 2011. The market does not value one species over the other, which is reflected in the same landed price. Along with the rise in value, landings for both species combined have increased from 288 tons in 2005 to 411 tons in 2011. Relatively little is known about current sea cucumber populations in California. The Department of Fish and Game is presently working to better understand the dynamics driving the fishery and how to address the key gaps in several key life history components. Initially this will include an analysis of the age structure and sex ratios for targeted individuals including spatial and seasonal variations. The goal of our work is to ensure that current management measures will provide for a sustainable cucumber fishery considering the dramatic increase in demand.

36. POST-RELEASE SURVIVAL AND BEHAVIOR OF DEEP-DWELLING ROCKFISHES (GENUS *SEBASTES*) SUFFERING FROM BAROTRAUMA: USING RECOMPRESSION DEVICES TO REDUCE BYCATCH MORTALITY

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Rockfishes (genus *Sebastes*) experience high rates of catch-and-release mortality associated with barotrauma. As these fishes are brought to the surface, gas in the gas bladder expands with the change in ambient pressure. This causes the gas bladder to rupture and leak gas into the visceral and cranial cavities often causing bloating, crushed organs, eversion of the esophagus, exophthalmia (bulging of the eyes), emphysema and emboli in various organs, and excessive buoyancy. Excessive buoyancy makes it difficult for many species to return to depth under their own power. Discarded rockfishes are thus often left floating on the surface where they eventually succumb to their injuries or predation. This study assesses the ability of deep-dwelling rockfishes to recover from barotrauma-related injuries if returned to depth using a descending device. Long-term survival and recovery of five rockfish species [sunset rockfish, *S. crocotulus* (n=12), bocaccio, *S. paucispinis* (n=12), bank rockfish, *S. rufus* (n=12), cowcod, *S. levis* (n=9), and starry rockfish, *S. constellatus* (n=3)] were monitored with VEMCO V9AP accelerometer and pressure sensing acoustic transmitters within an acoustic receiver array. Rockfish survival and movement patterns will be discussed in relation to fishing regulations and potential measures to reduce bycatch mortality.

37. THE POTENTIAL IMPACT OF KELP FOREST HABITAT RESTORATION ON THE GONAD PRODUCTION OF A SEA URCHIN FISHED COMMERCIALLY

Jeremy T. Claisse[1], Jonathan P. Williams[1], Tom Ford[2], Daniel J. Pondella[1], Brian Meux[3], and Lia Protopapadakis[2]. [1]Vantuna Research Group, Occidental College, Department of Biology, Los Angeles, CA, 90041; [2]Santa Monica Bay Restoration Foundation, 1 LMU Drive, North Hall Pereira Annex MS: 8160, Los Angeles, CA, 90045; [3]Santa Monica Baykeeper, 120 Broadway Suite 105, Santa Monica, CA 90401.

Harvesting red sea urchin (*Strongylocentrotus franciscanus*) for their gonads is one of the most important commercial fisheries in California. However, sea urchins in high densities, typically purple sea urchin (*Strongylocentrotus purpuratus*) and red sea urchin, can clear expanses of kelp forest, leaving the reef devoid of standing macroalgae resulting in "urchin barrens". To examine the potential of large-scale kelp restoration to positively impact the red urchin fishery along the Palos Verdes Peninsula, the extent of urchin barrens were mapped and measures of urchin density, size structure and gonad production were integrated using Monte Carlo simulations. Kelp forest and urchin barren habitat along the Palos Verdes Peninsula were significantly different in terms of urchin and kelp density. Mean test diameter of both red and purple urchin were also around 50% greater in kelp forest habitat. Modeling the relationship between gonad weight and test diameter demonstrated a clear difference in gonad production between habitats, with mean gonad biomass in red urchin peaking in May - 484% greater for red urchin at the legal size limit in kelp forest habitat. While urchins were more numerous in barrens, their limited gonad production would provide minimal yield to the fishery. When urchin density and size structure are incorporated with the gonad production model, restoration can potentially result in an 882% increase in urchin gonad biomass per unit area restored, offsetting losses in fishing habitat due to the establishment of MPAs in the region.

38. PATTERNS IN THE DISTRIBUTION OF COMMON KELP FOREST MACROINVERTEBRATES AND ALGAE ON SOUTHERN CALIFORNIA ROCKY REEFS

L.A. Fink, J.T. Claisse, J.P. Williams, and D.J. Pondella, II. Vantuna Research Group, Occidental College, Department of Biology, Los Angeles, CA, 90041.

A goal of California's Marine Life Protection Act (MLPA) is to conserve biodiversity. Therefore, understanding the spatial variability of communities over geographical scales is a crucial component to ecosystem-based management and essential for evaluating the performance of MPAs as a connected network in southern California. Using nMDS analyses we identify patterns and drivers in the distribution of common kelp forest invertebrate and macroalgal communities on rocky reefs along the mainland coast of southern California and at San Nicolas, San Clemente, Santa Catalina, and Santa Barbara Islands. Macroinvertebrate communities form regional clusters that appear to correlate with patterns in sea surface temperature with the largest differences in invertebrate community structure occurring between the coldest and warmest sites sampled. These results are similar to that found for kelp forest fish communities in the region. Algae communities showed less structure, and further work is needed to evaluate these patterns at finer scales incorporating differences in depth and habitat type.

39. DECLINING KELP FOREST ECOSYSTEM HEALTH AND POTENTIAL FISHERIES LOSSES DUE TO DESTRUCTIVE URCHIN GRAZING AT PALOS VERDES PENINSULA

J.P. Williams[1], J.T. Claisse[1], T.K. Ford[2], D.J. Pondella. II[1], and L.A. Fink[1]. [1]Vantuna Research Group, Occidental College, Department of Biology, Los Angeles, CA, 90041; [2]Santa Monica Bay Restoration Foundation, 1 LMU Drive, North Hall Pereira Annex MS: 8160, Los Angeles, CA, 90045.

Kelp forest ecosystems are productive features along the coast of California with services that span a wide array of consumptive and non-consumptive uses and support the state economy by bringing in $40+ billion a year in revenue. The relationship between kelp forests and their dependent species is well studied, as well as the relationship between urchin predation, urchin predators, and macroalgae. This study

represents the first comprehensive examination of the quantitative differences between giant kelp forest ecosystems and rocky reefs that are devoid of macroalgae at Palos Verdes Peninsula. SCUBA surveys were performed inside urchin barrens and at kelp forest reference sites. Site type (i.e. barren vs. kelp forest) had a significant effect on California spiny lobster, urchin, and macroalgal density, crustose coralline algae/bare rock percent cover, urchin test diameter, and kelp bass, California sheephead, and total fish density and biomass. With the substantial decrease in macroalgae, urchin predators, and other kelp forest obligates within urchin barrens, these reefs may exhibit decreased primary and secondary productivity for as long as the barrens persist. Considering that 152 acres of fishable reefs along the Palos Verdes Peninsula are in a barren state, this potentially represents a substantial loss for recreational and commercial fishing communities and may serve as a general warning regarding the health of the peninsula's rocky reefs.

40. USING LONG-TERM EXPERIMENTAL DATA TO ASSESS ROCKY REEF PERFORMANCE

S.C. Schroeter, D. Reed, and H.M. Page. University of California Santa Barbara, Marine Science Institute, Santa Barbara, CA, 93016.

The Wheeler North Reef (WNR), one of the largest artificial reefs along the west coast of North America, was constructed in 2008 as part of measures to mitigate for the impacts of the cooling water discharge from the San Onofre Nuclear Generating Station. Prior to the construction of the WNR, a large (22.5-acre) experimental reef comprising 8 treatments in a replicated randomized block design was constructed to determine which combinations of substrate type and bottom coverage would best meet performance goals of the much larger, 176-acre, WNR. Monitoring of the experimental reef has continued to the present, providing a 12-year time series. We provide some results of the monitoring of the physical and biological parameters that provide insights into the mechanisms underlying patterns of community development on the larger WNR, now in its fourth year post-construction,

41. THE ICHTHYOPLANKTON OF KING HARBOR, REDONDO BEACH, CALIFORNIA 1974–2009

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The Vantuna Research Group has been monitoring the ichthyoplankton of King Harbor, Redondo Beach on a monthly basis continually since 1974. In the southern California bight, this is the only long-term monitoring program of this nearshore larval fish assemblage. We report on twelve larval taxa, plankton volume and total larvae caught in monthly ichthyoplankton tows in King Harbor, Redondo Beach from 1974–2009. Plankton volume, total larvae, and all but three taxa significantly declined throughout this study. Larval declines were primarily correlated with plankton volume and negatively correlated with a rise in sea surface temperature (SST). Taxa that were not declining were represented by various gobies and *Hypsypops rubicundus*. Localized processes, red tides and other episodic events appeared to be associated with annual failures in larval production. With the exception of negative correlations with SST, oceanographic metrics (MEI, PDO, NPGO, NPI and CUI) were not correlated with larval catch for individual taxa. Instead SST, CUI and MEI may be explanatory for the decline in plankton volume, a potential major driver in the overall decline in late stage larvae during this study.

42. A NEW APPROACH TO BEACH ECOSYSTEM HEALTH

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To date no metric exists to evaluate the ecological health of sandy beaches. Traditionally managed for human recreation, beaches are also important natural ecosystems, a link between marine and terrestrial environments. Many animals and plants rely on this habitat for critical periods of the life cycle. Many common management practices and coastal industries may impact the inhabitants and ecological functions of the sandy beach ecosystem, but data to evaluate impacts is lacking. Recently, experts from academic, government, and environmental organizations began collaborating to develop the first metric for beach ecosystem health. The initial effort focuses on pilot sites for baseline surveys in southern California. Areas rich in natural resources will be compared with areas with intense human use. For each beach site, this baseline assessment of the natural environment will be followed by regular monitoring. Over time, the metric will provide rich new data for comparison and evaluation of impacts from natural disturbances, anthropogenic impacts, and beach management practices. Developing this metric will standardize monitoring methods to evaluate the ecological health and resilience of sandy beaches, and highlight sensitive resources to assist implementation of ecosystem-based management. Scientists and resource managers will improve ecosystem-based restoration or preservation, and will be better able to measure success of mitigation efforts. Detailed data on sandy beaches will provide greater understanding of ecosystem processes and seasonal rhythms on sandy beaches, to prepare for the future and compare to historic inventories.

43. HOW TO COUNT BARRED SAND BASS IN THEIR SPAWNING AGGREGATIONS

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We conducted a hydroacoustic (sonar) assessment of barred sand bass standing stock (abundance and biomass) using high resolution split beam sonar verified by both rod and reel sampling over sonar targets and underwater video observations. Once a target was verified (e.g., as an aggregation of barred sand bass), its target strength was related quantitatively to abundance and biomass. This feasibility study was conducted over five days in July (peak spawning months for barred sand bass) of 2010 over the 20–30m depth contour at Huntington Flats. Hydroacoustic transects were run on July 15, 16, 22, and 23, 2010 aboard the *RV Yellowfin* using a high resolution, split beam sonar unit, the *Biosonics DT-X*. Ten to twelve randomly placed, replicate, sonar transects were run each day. On shore, the complete BioSonics data files were transferred into Echoview ® 4.90 software files for full analysis of target identification, spatial location, target frequency analysis, target strength, and, ultimately, integration of target numerical density and biomass with defined regions of the daily cruise track. Mean target strength of barred sand bass was determined to be −35 dB. Over 95% of the sand bass targets were found between depths of 5 to 10 m over bottom depths 30 m. Estimated barred sand bass abundances varied between 16.8 and 239.8 bass per hectare over the four days of assessment. At 0.5 kg each, this corresponded to a range of standing stock between 8.4 to 120 kg per hectare.

44. DESCRIPTIVE TRENDS IN SOUTHERN CALIFORNIA BIGHT DEMERSAL FISHES BASED ON BIGHTWIDE SAMPLING: 1994, 1998, 2003, AND 2008

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The demersal fish communities throughout the Southern California Bight from the outer to inner continental shelf were sampled during the summers of 1994, 1998, 2003, and most recently in 2008 under a standardized methodology, inter-agency sampling plan. Summer water temperature at depth between 1950 and 2008 has remained relatively stable although temperatures in 1998 and 2008 were above the long-term mean while the 1994 and 2003 temperatures were at or below the mean. The mean demersal fish density increased each year between the 1994 and 2003 surveys before declining in 2008 while mean biomass has increased each year since 1994. The community structure has remained relatively consistent with the exception of 1998. Elevated biomass in 2008, despite the reduced abundance, was a function of increased mean fish length which reached its program maximum in 2008. The 2008 size structure was notably diminished in the smaller size classes and the overall distribution of fish lengths was truncated into fewer dominant size classes, suggesting fewer small individuals were present in 2008. This raises concern that despite peak or near-peak abundance and biomass in 2008, the community could be poised for a decline in the following years. Comparisons with environmental indices suggest the interannual variability was a reflection of environmental change over the time period. Increasing temperature, or similar patterns in

environmental indices, resulted in reduced density and biomass. Habitat valuation revealed a trend of increasing value with depth and latitude with the southern inner shelf areas scoring the lowest habitat value.

45. MONITORING SEAGRASS DENSITY IN A MARINE PROTECTED AREA OFF SANTA CATALINA ISLAND

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Big Fisherman's Cove at Santa Catalina Island is a listed Marine Protected Area (MPA) under the Marine Life Protection Act. It is a designated no take zone and provides habitat for numerous invertebrate and fish species. However, little is known about the ecosystem and its key foundation species. The surfgrass *Phyllospadix torreyi* was measured over a period of six months with underwater transects using SCUBA techniques to count shoot density over 50 meters set at six chosen headings. This study aimed to gather baseline density data and to develop long term monitoring protocol for future data collection. Over the study period, seagrass density was determined to have remained stable with relatively few changes in density. Each individual transect monitored did not show trending patterns regarding abundance, though some notable growth did occur in individual areas. Data loggers were deployed to monitor light intensity and temperature in these areas, with a decreasing trend overall for both.

Additional monitoring should be continued to completely determine the health of this MPA and any changes to the seagrass community. Seagrasses are importance ecosystem indicators of water quality due to their dependence on clear waters and sufficient light. This study can provide a baseline of information to compare future data and changes. While overall there was no change during the six-month monitoring period, this may be due to seasonality, reproductive timing, or other biophysical factors. Continued research of this area is important to monitor ecosystem health of this MPA.

46. PLASTIC RESPONSES OF WOOD DEVELOPMENT IN CALIFORNIA BLACK WALNUT (*JUGLANS CALIFORNICA*): EFFECTS OF IRRIGATION AND POST-FIRE GROWTH

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Plants may respond to varying environmental conditions by altering their internal xylem anatomy as it develops, impacting their ability to transport water, withstand water stress, or survive calamities. *Juglans californica* S. Watson is one of the dominant trees in Southern California woodlands and is well known for withstanding severe drought and resprouting following wildfires. Following a wildfire in one population of this species, unburned adult trees and new growth resprouts were compared. In a second population, irrigated and non-irrigated adults were compared. Plant stems were collected throughout the growing season and vessel diameter, vessel frequency, vessel lumen area, maximum vessel lengths, and other parameters were measured. There was a significantly greater vessel frequency and vessel lumen area in adults than in resprouts. Both growth forms demonstrated positive increases in percent conductive vessels, percent vessel lumen area, and hydraulic vessel diameter from February through June, with the addition of the new growth ring. Differences between growth forms in vessel diameter and frequency were correlated to higher mechanical strength and greater hydraulic conductivity in resprouts than in adult trees. In the second population, there was a significantly greater vessel frequency and somewhat narrower vessel diameters in irrigated trees. Thus the irrigated plants had more "xerophytic" xylem traits than non-irrigated plants. Preliminary results indicate maximum vessel length varies somewhat independently of vessel diameter. Non-irrigated adults had the greatest maximum vessel lengths, whereas resprouts had the lowest maximum vessel lengths. Thus plastic responses of developing wood may be more complex and interesting than expected.

47. GRAPEVINE CAVITATION RESISTANCE CAN BE ACCURATELY CHARACTERIZED USING A CENTRIFUGE TECHNIQUE

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Vulnerability to cavitation curves are used to estimate xylem cavitation resistance and can be constructed using multiple techniques. Two recent studies suggested that centrifuge-based vulnerability curves measured on long vesselled species were inaccurate because of an open vessel artifact. We examined the effect of vessel length on centrifuge vulnerability curves by manipulating the number of open vessels in one year old stems of a long vesselled liana (grapevine; *Vitis vinifera*). This was accomplished by using custom centrifuge rotors of different diameters. These curves were compared to a dehydration-based vulnerability curve. Although samples differed significantly in the number of open vessels, there was no difference in the vulnerability curves measured on 0.14 and 0.271 m long samples of grapevine ($P = 0.211$; $P_{50} = -0.16 \pm 0.03$ MPa for 0.14 m samples and -0.31 ± 0.11 MPa for 0.271 m samples). Dehydration and centrifuge-based curves showed a similar pattern of declining xylem specific hydraulic conductivity (K_s) with declining water potential. The percentage loss in hydraulic conductivity (PLC) differed between dehydration and centrifuge curves and it was determined that grapevine is susceptible to errors in estimating maximum K_s during dehydration due to the rapid formation of gels that block vessels. Our results from a long vesselled liana do not support the open vessel artifact hypothesis.

48. LEAF SHRINKABILITY WITH DEHYDRATION: A COMPONENT OF HYDRAULIC VULNERABILITY WITH ECOLOGICAL IMPLICATIONS?

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For over 100 years, the shrinkage of dehydrating leaves has attracted attention, especially as it becomes extreme during drought, and can potentially impact on the pathways of water transport, and their efficiency. Indeed, leaf thickness decreases with declining water status during transpiration, corresponding with the loss of turgor in mesophyll and epidermal cells. For 14 species diverse in phylogeny, leaf traits and drought tolerance, we determined leaf shrinkability in, leaf thickness and area and cell volume with dehydration, and its relationships with the vulnerability of leaf hydraulic conductance (K_{leaf}) and thus to loss of leaf function during drought, as well as its correlation with leaf structure, venation architecture, and pressure-volume curve parameters. Species varied in their shrinkablity (i.e., decline in size with declining water potential), with drought sensitive species showing substantial shrinkage in leaf thickness and area above turgor loss point, whereas drought tolerant species experienced minimal shrinkage above turgor loss point and moderate shrinkage below turgor loss point. Across species, K_{leaf} decline with mild dehydration (i.e., the initial slope of the vulnerability curve) was correlated with the degree of shrinkage above turgor loss point. The degree of shrinkage in thickness above turgor loss point was also correlated with a low elastic modulus and higher osmotic potential at full turgor. These findings point to a role for leaf shrinkability in hydraulic decline at high water potentials, with potential impacts on adaptation across scales from the cell to the leaf function to ecological distributions.

49. TRANSPORT AND MECHANICAL TRADEOFFS IN ROOTS OF EVERGREEN AND DECIDUOUS CHAPARRAL SHRUBS

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Safe transport of water is essential for plants growing in drought-prone environments. Water stress causes air bubbles (emboli) to block xylem conduits in a process known as cavitation. Roots are often highly vulnerable to cavitation, so roots may be particularly important in determining the ability of a plant to survive drought. We measured cavitation resistance, xylem specific hydraulic conductivity, and xylem density of roots for 24 species of chaparral shrubs grown in a common garden in Southern California. We examined tradeoffs among safety from cavitation, water transport efficiency, and xylem density. Further, we compared root traits between deciduous to evergreen species. We found the level of resistance to drought-induced embolism was inversely related to water transport efficiency and positively associated with xylem density. We also found evergreen species were more resistant to cavitation, had higher density xylem, and exhibited lower specific hydraulic conductivity than deciduous species. These results suggest a

tradeoff between xylem safety and efficiency and a link between structural support and cavitation resistance. Differences between evergreen and deciduous species suggest that leaf habit is linked to root xylem function. Xylem tradeoffs may shape plant strategies for dealing with drought stress. The diversity in root traits likely reflects adaptations to a broad range of niches in chaparral communities.

50. STRUCTURE AND FUNCTION OF LIVING VESSEL-ASSOCIATED CELLS AND THEIR ROLE IN PLANT HYDRAULICS

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Xylem is often thought of as largely dead tissue, and wood in particular is often characterized that way. Yet, xylem is far from dead, usually containing an abundance of living cells. Many plant species possess specialized living vessel-associated cells (VACs). The close association between living cells and dead xylem conduits creates a hydraulic problem for plants, because water potentials in xylem conduits often fluctuate widely diurnally and seasonally, creating a need for rapid and efficient osmotic adjustment in living xylem cells to avoid plasmolysis or overly high turgor pressures. Besides being involved in xylem osmoregulation, VACs are also the source of water for vessel refilling after embolism formation. Our previous study of 19 shrub species from different lineages and environments found a close statistical association between the abundance of VACs and the capacity to conduct embolism repair. To better understand relationships between structure and function of VACs, we conducted an anatomical survey of 21 shrub species, using light, SEM, TEM, and laser scanning confocal microscopy. VACs were found to be connected to vessels through large, half- to fully-bordered pits. Their cell walls were lignified, and pit membranes between VACs and other parenchyma cells were lignified and crossed by plasmodesmata. All VACs contained "protective" layers separating their plasmalemmas from secondary cell walls and pit membranes. Contrary to previous reports, starch grains were very common in VACs. The findings have implications for mechanisms of xylem osmoregulation and the function of VACs during vessel refilling.

51. DYNAMICS OF XYLEM SAP SALINITY IN TWIGS AND SHOOTS OF TWO MANGROVE SPECIES

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Xylem sap salinity in mangroves appears to impact hydraulic conductivity and possibly resistance to embolism. However, some reports consider high salinities a sampling artifact. We used two sap extraction techniques to measure sap salinity, and examined sampling artifacts. We measured the osmolality of successive 10 µl xylem sap drops extracted from twigs with a pressure chamber, extracted 150 µl samples, re-cut, and sampled again to test for contamination. Using 10 mm wide debarked stems, we collected successive drops with a vacuum extraction method. In a third experiment, we extracted sap samples from twigs as before, but allowed for an equilibration period of up to six hours before extracting more sap and determined its ion concentration. The osmolality of the first drops from the twigs was 400 and 110 mmol kg^{-1} for *Avicennina germinans* and *Laguncularia racemosa*. Osmolality decreased with successive drops, but re-cuts had no significant impact. In each species, the osmolalities in all stem collected samples were similar to the first two drops from the twigs. In the third experiment, sap osmolality increased up to three times the initial value after the equilibration period, and Cl^-, Na^+ and K^+ accounted for most of the ions. Results show that the initial drops from the twigs give accurate measurements of intact xylem sap, whereas continued extractions give lower osmolalities due to reverse osmosis. The twig can even exceed the initial osmolality if allowed enough time to equilibrate before new extraction. Thus, xylem sap salinity is meaningful and may play many roles.

52. RELATIONSHIPS AMONG STEM XYLEM HYDRAULICS, BIOMECHANICS, AND STORAGE FOR 36 SHRUB SPECIES OF THE CHAPARRAL COMMUNITY

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The three main functions of xylem in terrestrial woody angiosperms are the long distance transport of water, mechanical support of stems and leaves, and storage of water and nutrients. Tradeoffs among these functions are likely because these functions rely on different xylem cell types. We studied the tradeoffs among functional traits associated with each of the three main xylem functions in 36 species of shrubs that co-occur in the chaparral community of southern California. We also investigated how these traits differed between evergreen and deciduous species. Two key functional traits were measured to characterize water transport: 1) xylem specific hydraulic conductivity (K_s), a measure of water transport efficiency, and 2) the water potential at 50% loss of hydraulic conductivity (P50), a measure of vulnerability to water stress-induced xylem cavitation. We quantified biomechanical support by measuring stem mechanical strength (modulus of rupture; MOR) and xylem density. Carbohydrate storage was measured as the percentage starch present in stem xylem during autumn. For both evergreen and deciduous shrubs, K_s was negatively related to P50, indicating that species with greater resistance to water stress-induced cavitation had lower water transport efficiency. The percentage starch in xylem was negatively related to P50 and positively related to K_s across all species, suggesting a tradeoff between carbohydrate storage and cavitation resistance. These relationships were not significant when analyzed using phylogenetically independent contrasts, suggesting that the observed functional trait relationships were not the result of correlated evolutionary shifts, but rather the result of community assembly processes.

53. DEVELOPMENTALLY-BASED SCALING OF LEAF VENATION ARCHITECTURE EXPLAINS GLOBAL ECOLOGICAL PATTERNS

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Leaf size and venation show remarkable diversity across dicotyledons, and are key determinants of plant adaptation in ecosystems past and present. We present global scaling relationships of venation traits with leaf size: across a new database for 485 globally distributed species, larger leaves had major veins of larger-diameter but lower length per leaf area, whereas minor vein traits were independent of leaf size. These scaling relationships allow estimation of intact leaf size from fragments, to improve hindcasting of past climate and biodiversity from fossil remains. The vein scaling relationships can be explained by a uniquely synthetic model for leaf anatomy and development derived from published data for numerous species. Vein scaling relationships can explain the global biogeographic trend for smaller leaves in drier areas, the greater construction cost of larger leaves, and the ability of angiosperms to develop larger and more densely vascularized lamina to outcompete earlier-evolved plant lineages.

54. ARE CHAPARRAL SHRUBS HYDRAULICALLY ADAPTED TO THE REGENERATION, ADULT, OR PERSISTENCE NICHES?

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Ecophysiologists often focus only on the adult phase of the life cycle and assume that adult functional traits are adaptive to the environment of the adult (the adult niche), even though traits may be under strong selection at other stages of the life cycle. We tested if key plant functional traits (stem cavitation resistance, hydraulic conductivity, and xylem density) of evergreen chaparral shrubs are better understood as adaptive to their adult, regeneration (seedling), or persistence niches (post-fire resprouting

environment). We found that at the minimum seasonal water potential, seedlings were closer to the point of runaway cavitation than adults and resprouts, suggesting that cavitation resistance is critical for seedling survival during regeneration. For intraspecific comparisons of cavitation resistance, seedlings and adults were not different, whereas adults were more resistant to cavitation than resprouts. Cavitation resistance was significantly correlated between seedlings and adults ($r = 0.96$) and between adults and resprouts ($r = 0.78$) (same species data were not available to analyze seedlings to resprouts). Xylem density was correlated between resprouts and adults ($r = 0.89$), whereas other traits and seasonal minimum water potentials were not correlated. We conclude that the level of cavitation resistance of a chaparral shrub is most strongly shaped by selection during the regeneration niche. Although we found evidence for plasticity in cavitation resistance between resprouts and adults, significant correlations for cavitation resistance between adults and seedlings, and adults and resprouts suggests developmental and ecological limitations to the plasticity of this trait.

55. LEAF HYDRAULIC CONDUCTANCE FOR TANK BROMELIADS: THE EFFECTS OF LIGHT AND PH

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For tank bromeliads, the leaf hydraulic pathway is nearly identical to that of the entire plant. The roots function largely as holdfasts, and water is absorbed through the leaf bases that form the tank. Water absorption and transport are thus regulated by leaf properties, which in turn are influenced by environmental factors. For many species, leaf hydraulic conductance (k_{leaf}) is responsive to light, often but not always increasing as irradiance increases. For a number of species of tank bromeliad that occur at several heights in the canopy at La Selva Biological Station in Costa Rica, we have investigated leaf properties, particularly anatomical variables associated with k_{leaf}, as well as possible interactions between the pH of tank water, light, and plant water uptake. For bromeliads at La Selva, the pH of tank water is frequently lower than 4.0, a level that has been shown to close aquaporins (protein channels that regulate water movement across membranes); in addition, we have observed pH to be lower for plants in higher light. For *Aechmea nudicaulis* and *Guzmania monostachia*, k_{leaf} for plants taken from about 40 m in the canopy was 50% and 24% greater, respectively, than for plants growing 15–20m lower in the canopy, and a similar pattern held for two species of *Werauhia* that occurred at different heights. Preliminary measurements suggest that water uptake did not decrease as pH in the tank decreased, suggesting that absorptive epidermal scales may help to buffer changes in pH, thereby permitting continued water entry into leaves.

56. QUANTIFICATION OF METHANOGENIC MICROBES ASSOCIATED WITH TROPICAL BROMELIADS: INFLUENCES ON FUNCTION AND ABUNDANCE

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Plants within the family *Bromeliaceae* possess foliage arranged in compact rosettes capable of retaining water. This unusual freshwater environment allows for the growth of anaerobic methanogenic archaea, which are the sole biological producers of methane, a potent greenhouse gas. This study sought to quantify the methane production capacity of the microbial community by measuring, via quantitative PCR, the methyl coenzyme M reductase (*mcrA*) gene, which encodes for an enzyme that catalyzes the final step in the production of methane. Quantitative PCR was performed on bromeliad tank DNA extracts, using previously designed primers for both *mcrA* and 16S rRNA (the latter of which was used to measure archaeal abundance). With the assumption that environment influences gene expression, *mcrA* copy numbers (which ranged from 1.6×10^6 to 7.1×10^7 copies per ng of extracted DNA) were compared to environmental variables, including plant height, tank pH, and photosynthetically active radiation (PAR) levels. A significant correlation was observed between *mcrA* gene copy number and plant height ($P = 0.0009$) suggesting that the methanogenic potential of the microbial communities increases with host plant height. This was confirmed by analysis of a series of clonal bromeliads, ranging from 2 to 7 cm tank depth, which only assayed positive for *mcrA* if larger than 4 cm tank depth. Analysis of 16S rRNA QPCR data revealed that archaeal microbial abundance ranged from 2.0×10^3 to 1.1×10^6 cells per ml of tank fluid, and

generally exhibited a similar pattern of increasing cells with plant height. Finally, analysis of 4 artificial tanks paired with natural bromeliads, in the forest for 6–12 months, showed no methanogenic capacity except in two cases, in which the artificial tanks contained a large amount of organic detritus and had low pH values, suggesting that these particular factors may influence the suitability of the bromeliad habitat for methanogenic microbes.

57. VARIATION ACROSS CALIFORNIAN PLANT COMMUNITIES IN LEAF BIOMECHANICS AND SCALING WITH MORPHOLOGICAL TRAITS

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Leaf biomechanical properties have important impacts on a wide range of plant processes, from plant water relations to leaf economics to plant-animal interactions. However, little is known about the underlying mechanisms that determine environmental variation in leaf biomechanical traits, and their linkage with other leaf traits. We tested hypotheses for the relationships between and 8 biomechanical leaf traits and16 morphological traits for 21 species distributed in chaparral, coastal sage, and Mojave desert communities of southern California. We tested the variation across species and habitats of the biomechanical resistance of the whole leaf and its component tissues, and for correlations within and across species with leaf size and density. We found strong variation across species and habitats for leaf mass per area, total leaf density, leaf lamina density, and the leaf tensile modulus of elasticity (TME) and tensile strength (TS). The TME and TS were higher for the midribs than for intercostal areas and were highly correlated across and within species. Notably, axial and midrib TME were nearly 10 times higher in species of chaparral than in species of coastal sage communities. Southern California plant communities can be ordered from having "soft" leaves in the coastal sage to "hard" leaves in the chaparral. Most biomechanical traits showed correlations with leaf area and/or leaf density. Our results support multiple mechanisms underlying important differences in leaf tensile resistance within and across species, and a dramatic correspondence of leaf biomechanical properties with environment.

58. RAPID DETERMINATION OF COMPARATIVE DROUGHT TOLERANCE TRAITS: USING AN OSMOMETER TO PREDICT TURGOR LOSS POINT

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Across plant species, drought tolerance and distributions with respect to water availability are strongly correlated with the physiological traits leaf water potential at wilting, i.e, the turgor loss point (π_{tlp}), and cell solute potential at full hydration, i.e., the osmotic potential (π_o). However, ecosystem-scale studies of plant drought tolerance are often limited by the time-consuming and laborious standard pressure-volume (p-v) curve methods. Thus, we optimized existing methods for measurements of π_o using vapor-pressure osmometry of freeze-thawed leaf discs from 30 species from two precipitation regimes, and developed the first regression relationships to accurately estimate pressure-volume curve values of both π_o and π_{tlp}. The π_o determined with the osmometer (π_{osm}) was an excellent predictor of the π_o determined from the p-v curve (π_{pv}, $r^2 = 0.80$), and an even stronger prediction of π_{pv} could be made using π_{osm}, leaf density (ρ), and their interaction ($r^2 = 0.85$, all $p < 2 \times 10^{-10}$). The π_{osm} alone was the best predictor of π_{tlp} ($r^2 = 0.86$); indeed, the π_{osm} was a better predictor than leaf mass per unit area (LMA; $r^2 = 0.54$), leaf thickness (T; $r^2 = 0.12$), ρ ($r^2 = 0.63$), and leaf dry matter content (LDMC; $r^2 = 0.60$), which have been previously proposed as drought tolerance indicators. This osmometer method enables accurate measurements of drought tolerance traits for plants with diverse leaf types and habitat preferences, at a 95% reduction in time and effort compared to pressure-volume curves. We expect this approach to have wide application for predicting species responses to climate variability, and to assess ecological and evolutionary variation in drought tolerance.

59. WATER RELATIONS OF DESERT TREES AS RELATED TO GROUNDWATER REMOVAL IN THE NORTHERN SONORAN DESERT

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Recent land development has greatly impacted the flora of the Mojave and Sonoran Deserts. One of the changes brought forth by increased human land use is the removal of groundwater from aquifers. To provide water for a construction project, a well was created during the late fall/winter of 2011/2012 in a large wash at the base of the Chuckwalla Mountains in the Sonoran Desert of Southern California. The wash is dominated by several perennial shrubs and trees, the tallest being *Cercidium floridum* (blue palo verde), a tree that typically relies on shallow soil water from seasonal rains, and *Olneya tesota* (desert ironwood), a phreatophyte that utilizes relatively deep stable water sources. Water relations, including predawn and midday water potentials and stomatal conductance, and the phenological and morphological characteristics of both species are being studied at six sites in the wash to determine whether groundwater removal is affecting these two tree species. To this point, changes in water relations and phenology of both *C. floridum* and *O. tesota* over time appear to be related to seasonal changes in rainfall and temperature rather than to water removal from the well. There are significant differences in water relations and morphology for *O. tesota* among the different sites in the wash, with tree size and water potential being positively correlated with the depth of the channel in which they occur; thus, it appears that *O. tesota* utilizes a significant amount of shallow subsurface water, when available. It is believed that this study could provide some of the most important evidence on whether removal of water from aquifers has a measurable impact on desert flora.

60. IF RUNOFF IN A SMALL WASH IS CUT OFF IN THE DESERT, DO THE PLANTS FEEL IT?

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Small washes create a complex hydrological network across desert bajadas, but represent only a small proportion of the bajada's spatial area. Nonetheless, these channels may be the most important geomorphic feature influencing local vegetation properties and processes. We examined the functional influence of small channels on the vegetation of a Mojave Desert bajada by conducting studies that compare an undisturbed area versus that influenced by a ~100 year old disturbance (railroad and parallel road). Below the disturbance, where flow has been either increased due to channel coalescence or cut off due to diversion, plant community structure and cover has changed relative to the undisturbed area. Plant responses to simulated runoff, conducted in undisturbed and cut-off channels, revealed subtle but consistent differences that may contribute to vegetation changes. In both channel types, creosote bush (*Larrea tridentata*) within 3 m, and white bursage (*Ambrosia dumosa*) within 2 m of the channel acquired channel water, however, the plant responses to channel pulses differed between channel types. These findings suggest that root patterns and plant functions associated with channel water are altered when flow is reduced or eliminated over extended periods of time. Such disturbance of small desert washes may lead to vegetation shifts and consequences that are not yet fully realized. Although these small washes represent a minor spatial component of the bajada landscape, runoff, higher infiltration rates, and their influence on adjacent plants suggests that these modest geomorphic features may have a disproportionate impact on the function of these arid ecosystems.

61. THE ANATOMICAL BASIS OF LEAF WATER RELATIONS ACROSS DIVERSE SPECIES

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The greatest challenge to terrestrial plant life is overcoming the relative moisture deficit. The resulting struggle between maximization of photosynthesis and costs of water transport has produced great diversity in plant anatomical and physiological traits. Consequently, understanding of plant water use

and response to drought are of vital global importance. Leaf physiological water use has been studied extensively, yet a disconnect remains in our understanding of the physiological processes which prevent transpiration and dehydration from creating lethal stress, and the diversity of anatomical structures within the leaf. For 14 phylogenetically and structurally diverse species growing in southern California, we quantified leaf cross sectional tissue thicknesses, cells sizes, and venation architecture. We hypothesized correlations with both maximum hydraulic capacity and drought tolerance traits. We comprehensively explore the linkage of these anatomical traits with the species' leaf hydraulic capacity (K_{leaf}) and vulnerability to decline with dehydration and to recover with rehydration, as well as with pressure volume curve parameters. This work clarifies the anatomical underpinnings of leaf water transport capacity and adaptation to water supply.

62. THE INTERACTING EFFECTS OF WATER AVAILABILITY AND ATMOSPHERIC CO_2 PLAY A MORE IMPORTANT ROLE FOR LONG-TERM GROWTH OF MEDITERRANEAN TREES THAN WATER-USE EFFICIENCY

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The impact of global change drivers on Mediterranean forests will rely on the individual responses and acclimation capacity of each population and species. To investigate patterns of physiological plasticity over time in continental Mediterranean forests (central Spain), we analysed trends in intrinsic water-use efficiency (WUEi) and growth of co-occurring dominant tree species (*Quercus faginea, Pinus nigra, Juniperus thurifera*) between the 1970s and the 2000s. Structural equation models showed that the observed rises of WUEi were not translated into growth increases for any species, even showing a negative relationship with growth for *J. thurifera*. For this species, the positive effect of atmospheric CO_2 (C_a) on growth compensated the negative effect of increased WUEi, leading to a net growth enhancement over time. Overall, there were significant effects of the water availability $\times$ C_a interaction on tree growth. While *Q. faginea* growth mainly responded to water availability and *J. thurifera* to C_a, growth of *P. nigra* depended on the balance between both variables. Beyond the global temporal trends observed, at the site level, mesic sites were the most affected by climate variability, with the overall growth being lower for all species as compared with more xeric conditions. The results delineate a more favourable future scenario for *J. thurifera* populations. Instead, populations of *P. nigra* and *Q. faginea* are reacting negatively to the increasing drier years, which are unlikely to be compensated by higher C_a concentrations. All this indicates that carbon uptake by Mediterranean forests will be strongly affected by future species composition.

63. EFFECT OF EXOTIC GRASS REMOVAL AND NATIVE SEED AUGMENTATION ON RE-ESTABLISHMENT OF COMMON OAK UNDERSTORY SPECIES ON SANTA CATALINA ISLAND, CALIFORNIA

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As in many oak ecosystems in California, there is limited recruitment of native oak trees on Catalina Island. Island scrub oak and associated plant species are being replaced by exotic annual grassland. In one transforming oak stand on Catalina Island we tested the effect of two restoration techniques on the recruitment of common native oak understory species. We hypothesized that exotic annual grass removal and seed augmentation would increase native understory cover and native richness. A two-factorial experimental design was used in which seeds of 8 understory species were added in October, 2008 and

grass-specific herbicide was applied in January, 2009. Although there was seasonal fluctuation in the effectiveness of the restoration techniques, overall, these treatments tended to positively affect native species responses and adversely affect annual grass responses. Herbicide treatment significantly increased native cover in 2010. Seed addition significantly increased native cover in both 2009 and 2010 and species richness in 2009. Herbicide treatment reduced exotic annual grass cover in both 2009 and 2010, perhaps facilitating the increased cover of native species in 2010. These findings suggest that land managers faced with the encroachment of exotic annual grasses in areas previously inhabited by a scrub oak ecosystem can restore native understory community structure by the combined use of grass-specific herbicides and seed augmentation of native understory species.

64. IS SPERM COMPETITION RISK MEDIATED BY SOCIAL CUES IN THE PACIFIC FIELD CRICKET *TELEOGRYLLUS OCEANICUS?*

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Sperm competition (SC) game theory predicts that males should increase ejaculate expenditure as sperm competition risk increases. Most studies to date have experimentally manipulated SC risk by using direct physical interactions between conspecific males. More recently, investigators have suggested that more indirect social cues, such as acoustic, visual, or olfactory cues, may indicate SC risk. We looked at one such indirect cue by rearing individual male Pacific field crickets, *Teleogryllus oceanicus,* in either song-dense or song-free acoustic environments, mimicking 'high SC risk' and 'low SC risk' situations. This also mimics the natural acoustic environment of this species; on some Hawaiian islands, a wing mutation has silenced male crickets. Islands with many of these silent males have an acoustic landscape very different from islands with normal males. We measured male ejaculate expenditure by assaying sperm viability, the percentage of live sperm contained within a fresh spermatophore. Consistent with SC game theory, males reared in song-dense environments had greater sperm viability than males reared in song-free environments, indicating that males may use social cues to gauge SC risk.

65. MALE REPRODUCTIVE STATUS DOES NOT ALTER HYPOTHALAMIC-PITUITARY-ADRENAL (HPA) AXIS ACTIVITY OR REACTIVITY IN A MONOGAMOUS, BIPARENTAL RODENT, THE CALIFORNIA MOUSE (*PEROMYSCUS CALIFORNICUS*)

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Glucocorticoids, the end products of the HPA axis, are produced in response to stressful events as well as in a circadian rhythm, and circulating concentrations can change with age, season and social and reproductive conditions. Stress and glucocorticoids (cortisol and corticosterone) have been implicated in mediating a trade-off between self-investment and reproductive behavior. In several species, stressful situations lead to decreased reproductive investment, including both sexual and parental behavior. Therefore, decreased HPA activity and reactivity in parentally behaving animals may be adaptive if reproductive effort could be buffered from the detrimental effects of stress. We tested this hypothesis using male California mice in three different reproductive conditions (n = 12 per group). Virgin males were housed with another male, non-breeding males were housed with a tubally ligated female, and fathers were housed with their pairmate and first litter of pups. We characterized plasma corticosterone levels at baseline, following stress, and following injection with dexamethasone and corticotropin-releasing hormone to suppress or stimulate the HPA axis, respectively. Following the 16-day protocol, animals were dissected, and testes and adrenal glands were weighed. There were no differences in baseline, stress-induced or pharmacologically manipulated corticosterone levels among the male reproductive conditions, suggesting that the HPA axis is not modulated with reproductive status in male California mice. However, fathers had smaller adrenal glands when compared to both virgin and non-breeding males.

66. THE FOSSIL RECORD OF ECOLOGICALLY THREATENED FISH SPECIES: THE DEEP HISTORY OF TUI/ARROYO CHUBS (*SIPHATELES)* OF THE MOJAVE AND SOUTHWESTERN GREAT BASIN, EASTERN CALIFORNIA, USA

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Fossil fish remains from several localities in eastern California indicate that endangered chubs (i.e. *Siphateles mohavensis, S. bicolor snyderi,* and *S. bicolor orcutti*) may have a significant paleontological history, and that conservation efforts may benefit from enhanced paleoecologic study. Fossil specimens of *S. bicolor* have been recovered from Pliocene lacustrine limestone of the Coso Formation near Haiwee Reservoir on the western flanks of the Coso Range, southern Owens Valley. Potassium-argon dating of tuff (Bacon and others, 1982) stratigraphically above the fossil horizon suggests that chub species were present in aquatic ecosystems of the region soon after the tilting of the nearby Sierra Nevada and the development of the aquatic isolation of the western Great Basin and Mojave provinces, definitively no younger than 3.0 Ma. Fossil *S. mohavensis* pharangeal teeth recovered from a gravel quarry on the northwestern flank of Silver Lake, occur in unionid bivalve/gastropod/ostracode-rich siliciclastics associated with tufa-coated boulders and cobbles. Those specimens based on carbon-dated bivalves are Pleistocene-Holocene, i.e. no older than 13.7 Ka and no younger than 8.3 Ka (Wells and others, 2003). Additionally, isolated bones of *S. mohavensis* from Pleistocene Lake Manix beds reported by Smith and others (2002), as well as bones assignable to *S. mohavensis*? have been reported from several Lake Mojave drainages (Reynolds and Reynolds, 1985; Roeder, 1985; Jefferson, 1985). Fossil chub occurrences suggest that chub species have profoundly survived the past 3.0 Ma of fluctuating regional climate patterns affecting this general area.

67. A NEW, HIGHLY ACCURATE METHOD FOR PHOTO-IDENTIFICATION BASED ON FACIAL RECOGNITION SOFTWARE

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Photo-identification has been used as a tool for biological research for several decades as a noninvasive method for recognizing animals across a wide range of taxa from marine mammals to invertebrates. It started as a search through a catalog of photographs; now mostly computer-assisted criteria matching or pattern recognition programs. Yet it still requires manual identification/confirmation for a successful match. We created an analysis program using current facial recognition algorithms. We present data on initial tests with an inanimate object. We selected 100 US pennies used as a "Knowledge Base" in 4 experiments. In Experiment 1, illumination/angle of the photo remain controlled. In Experiment 2, illumination was varied. In Experiment 3, angle was varied. In Experiment 4, illumination and angle were varied. Each set was tested with 4 conditions: control, varied illumination, varied angle, and varied illumination/angle. These subsets consisted of 10 US pennies from the Knowledge Base, 10 random US pennies, one Canadian penny, and one US dime. Each of the 4 experiments were computed for 64m iterations (16m iterations per sub-test). US dimes and Canadian pennies resulted in outgroup placement from the US pennies. 4 images had false positives during the analysis, but for no more than 2 of 16 million iterations per test, giving very strong support for the end result. All Knowledge Base pennies were correctly found. This preliminary analysis is encouraging for individual identification of highly patterned species, and for species lacking distinguished patterns. We hope to test this next on coastal California elasmobranchs.

68. HAS OUR LOVE AFFAIR WITH PLASTIC GONE TOO LONG? THE RELATIONSHIP BETWEEN BPA IN PLASTIC AND DEMOGRAPHIC FACTORS

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Bisphenol A (BPA) is used to manufacture polycarbonate plastic, and is present in compact discs, beverage containers, and toys. Manufacturers also utilize BPA epoxy resins in linings of food cans and dental sealants, to name a few, as well as other products. BPA's effects on human species are controversial

and inconclusive. Centers for Disease Control - CDC states that the effects of low levels of environmental BPA exposure are unknown. BPA's effects on human species are controversial and inconclusive. Amount of BPA that has entered the body can be estimated from the levels of BPA in the urine. Results of such measurement were published in the Fourth National Report on Environmental Chemicals, and it was found that there is widespread exposure to BPA in the US population. This report will determine the relationship between levels of BPA in the urine and age, ethnicity, and gender. CDC scientist measured urinary levels of BPA of 2,517 participants, aged 6 years and over, who took part in National Health and Nutrition Examination Survey (NHANES) for the years 2003–04 (CDC, 2011). Data for levels of urinary Bisphenol A (2,2-*bis*[4-Hydroxyphenyl] propane) was taken from the NHANES. SPSS was used to analyze the data. This report found that there is no association between demographic variables and levels of urinary BPA. Presence of BPA in urine is widespread and is not concentrated in a specific age group, ethnicity, or gender. The report will discuss possible confounding factors involved in relationship between the presence of BPA and demographic factors.

69. TESTING PERMEABILITY OF SELECT EPITHELIA IN *MEGATHURA CRENULATA* TO TRACERS USING ELECTRON MICROSCOPY

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For the commercial extraction of KLH, a molecule used in clinical trials for the treatment of cancer, giant keyhole limpets are bled to remove up to 20% of their body weights. Limpets recover their weight in a few days by the influx of seawater, and we wonder if this is a potential avenue for infection by pathogens. I determined sites of water influx and the permeability of selected epithelia by bleeding limpets and then soaking them in several tracers (India Ink, $LaNO_3$, cationic ferritin and anionic ferritin) in seawater and then using transmission electron microscopy (TEM) to follow their distribution in the limpet body. The thick layer of mucus coating the mantle, foot and gills protected these sites from particle uptake and the esophagus emerged as the likely place of possible microbial infection. However, even the smallest tracer (lanthanum, <2nm diameter) was unable to penetrate the septate junctions connecting epithelial cells. When epithelial cells were removed by EDTA, tracers were unable to penetrate the thick basal lamina. This indicates that the epithelial cells of *M. crenulata* create a formidable barrier to potential pathogens.

70. ASSESSING LONG-TERM TEMPORAL AND SPATIAL VARIATION IN SETTLEMENT OF *OSTREA LURIDA* IN NEWPORT BAY, CA

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The continued lack of recovery of the United States west coast populations of the Olympia oyster, *Ostrea lurida* has piqued recent interest in restoration projects. Knowledge about temporal and spatial variation in larval settlement provides baseline information about which locations receive the most larval input and have the potential to support large populations, facilitating selection of future restoration sites. We monitored larval settlement by placing replicate ceramic tiles (n=4) at six locations within Upper and Lower Newport Bay, Newport, California from 2007 to 2011. Tiles were replaced at 2-week intervals during the oyster reproduction season (May–Oct), and1-month intervals during the remainder of the year. *O. lurida* settlers were counted using a dissecting microscope. We converted settler counts to cumulative numbers of settlers/m^2 across months and across years. Settlement occurred from May until November throughout all 5 years of our data entry with peaks typically occurring in June or August, or both. Highest settlement in the upper bay usually occurred at Rocky Point and, in the lower bay, at 15th Street. Future research will focus on exploring factors, such as local adult density, salinity, and/or temperature that may explain variation in settlement among sites.

71. PHYSIOLOGICAL CONSEQUENCES OF THERMAL STRESS ON GROWTH AND SURVIVAL OF THE MARINE SNAIL, *LOTTIA GIGANTEA*

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Marine intertidal invertebrates are likely to be especially vulnerable to global warming as their physiology, behavior, and demography are all critically influenced by local environmental temperatures. Nevertheless, the mechanistic links between abiotic conditions and individual performance are not yet well understood. We are using the owl limpet, *Lottia gigantea*, as a model organism to identify the physiological consequences of thermal stress on key demographic parameters. Abundances of *L. gigantea* in the mid-intertidal zone are negatively related to maximum temperature, suggesting that this species may already be living near its upper thermal tolerance limits. We transplanted marked limpets into intertidal plots across a wave exposure gradient on a rocky headland in Rancho Palos Verdes, CA, and tracked limpet growth and survival monthly as a function of local temperatures and food availability. We also exposed limpets to one of two body temperatures (18°C and 32°C) for several hours during a simulated low tide under controlled conditions in the laboratory before extracting and analyzing proteins from gill tissues. Environmental proteomics is a biotechnological approach that allows one to analyze simultaneously the expression levels of many proteins in response to different environmental conditions. Protein expression profiles varied characteristically among treatment groups; we are currently working to identify with mass spectrometry the proteins most responsible for those differences. The ability to link effects of abiotic stress on individual growth and survival to protein-based bioindicators will provide insight into the potential responses of individuals and populations to future environmental conditions.

72. DETERMINING THE SOURCE AND VECTOR FOR INVASIVE POPULATIONS OF THE JAPANESE BUBBLE SNAIL, *HAMINOEA JAPONICA* (PILSBRY, 1895)

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Haminoea japonica is an opisthobranch mollusk with a large non-native range that is a vector for a parasite that causes the human skin disease cercarial dermatitis, and may have negative effects on populations of native species. Molecular evidence from the mitochondrial cytochrome c oxidase I gene and the histone 3 nuclear gene indicates that previously published morphology-based hypotheses on the spread of *H. japonica* out of Japan are correct. The most likely explanation for the current range of the species, which includes Japan, Korea, France, Spain, Italy, Canada and the USA is a recent, human-mediated dispersal from Japanese populations. The highest levels of nucleotide and haplotype diversity are found in Japan. Non-native populations have low levels of genetic diversity (indicating bottlenecking) and the most common non-native haplotype has been found in only two localities in north-eastern Japan. In addition, the haplotype network structure and spatial analysis of molecular variance (SAMOVA) results confirm that non-native haplotypes most likely originated in north-eastern Japan, which is where most Pacific oyster exports to North America also originated. Because no non-native haplotypes can be traced back to Tokyo Bay (where most shipping traffic originates) and there are no major shipping ports in north-eastern Japan, ballast water is less likely to be the mechanism of dispersal. The results of this study provide important data for the development of policies and regulations aimed to prevent further spread of this species in non-native ranges.

73. ANTI-PARASITE BEHAVIOR IN THE CALIFORNIA FIDDLER CRAB, *UCA CRENULATA*: EFFICACY AND SEX DIFFERENCES

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Despite being effective ways to avoid and reduce infection, anti-parasite behaviors are relatively understudied. The California fiddler crab (*Uca crenulata*) is host to several helminth parasites, most notably the trematode *Probolocoryphe uca*. Crabs exposed to *P. uca* exhibit increased mortality, thus anti-parasite behaviors may be important to host fitness. Sex differences in host claw morphology could also affect infection rates in crab hosts. While females possess two small claws for feeding and grooming, males have one while the other claw is enlarged for use as an ornament and weapon. We predicted that crabs exposed to *P. uca* would exhibit anti-parasite behaviors to reduce infection. Due to differences in claw morphology, we also expected that males would be less effective at removing

parasites than females, resulting in higher parasite abundances. To test these hypotheses we exposed crabs to *P. uca* larvae, scored various behaviors, and dissected them for parasites. Exposed crabs exhibited significantly higher rates of grooming, feeding, and leg rubbing than did unexposed crabs. Although males groomed significantly more often than females, they harbored twice as many *P. uca* trematodes, consistent with our predictions. While the enlarged claw affords males protection from rivals and ornamentation for mate attraction, it may also compromise their ability to behaviorally remove parasites.

74. VARIANCE IN AGGRESSION LEVEL IN AMONG AND BETWEEN SPECIES PAIRINGS OF POLYCHAETOUS ANNELIDS IN THE *NEANTHES ACUMINATA* COMPLEX

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The *Neanthes acuminata* complex consists of four morphologically identical species: *Neanthes acuminata* from the Atlantic coast of the United States, *Neanthes arenaceodentata* from the Pacific coast of the U.S., Hawaii, and Mexico, *Neanthes caudata* from Portugal, and *Neanthes cricognatha* from India, the Philippines, and Hong Kong. Aggression level in worms of the *N. acuminata* complex, as determined by percentage of trials ending with death, was analyzed to determine whether worms in the species *N. caudata* showed increased aggression towards *N. arenaceodentata* specimens. The baseline for comparison was set by examining interactions among *N. arenaceodentata* specimens from different locations: Los Angeles Harbor, San Gabriel River, and Newport Beach, which acted as controls. Worms were paired both within each population (ex. LA Harbor male with LA Harbor female), and with the other two populations (ex. LA Harbor male with Newport female). Portuguese worms were paired within their species and with all three populations of *N. arenaceodentata*. Trials ended when a worm was killed or the female laid ova. The percentage of aggressive trials that included a Portuguese worm paired with a *N. arenaceodentata* worm was significantly higher than the percentage of aggression seen in control pairings. Previously it was found that intersexual aggression is rare within the *N. acuminata* complex, so this increased level of aggression may be indicative of premating isolation that has developed between the species. It is likely *Neanthes* worms of different species have unique pheromones, although further testing is required to prove this.

75. VARIABILITY IN THE POLYCHAETOUS ANNELID *NEANTHES ACUMINATA* COMPLEX: PROGRESS REPORT NUMBER 2

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Morphologically identical species comprise what is referred to as the *Neanthes acuminata* (New England) complex. Other species in the complex include *N. arenaceodentata* (Southern California, Hawaii, Mexico), *N. caudata* (Portugal), and *N. cricognatha* (India, Asia). All species in this complex have been cultured at California State University, Long Beach with the exception of *N. cricognatha*. Previously, three populations from southern California were grouped together on basis of chromosome number, DNA, and color. Crosses between red eye and black eye worms resulted in all red eye offspring through the F2 generation. The population from Connecticut differed in chromosome number and color. The population from Venice, CA is similar to those from Connecticut in color, but the chromosome number is unknown for the Venice worms. Additional data now include specimens from Alamitos Bay, CA, two localities in Baja CA, Hawaii and Portugal with analysis including gene CO1. Populations from LA Harbor and Newport Bay grouped together and were separated geographically from the intermediate locality (San Gabriel River). The San Gabriel River worms form a group with subgroups from Venice, Alamitos Bay and the two localities from Baja California. Polychaetes from Portugal are separated from the others. No data on gene CO1 are available for Connecticut and Hawaii populations at this time.

ABSTRACTS FOR POSTER SESSION

76. ANATOMICAL, HISTOLOGICAL, AND MOLECULAR CHARACTERIZATION OF THE VENOM OF *SQUALUS ACANTHIAS* AND *HETERODONTUS FRANCISCI*

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Chondrichthyian fishes are now known to include many venomous taxa, but most of what is known about the venom molecules and delivery apparatuses in this group comes from studies of the batoids. The distribution pattern and content of venoms found in either the chimaeras or sharks have never been documented and remains poorly understood. Within sharks the taxonomic families Squalidae, Etmopteridae, and Heterodontidae are known to possess fin spines that could be potentially venomous. Here, histological examination of fin spine tissues and basic biochemical and toxicological analyses of fin spine extracts from several specimens of *Squalus acanthias* and *Heterodontus francisci* are used to both confirm the presence of and provide a basic description of the venom in these groups.

77. PHYSIOLOGY AND BEHAVIOR OF WHITE SEABASS *ATRACTOSCION NOBILIS* IN A FULLY CLOSED RECIRCULATING SYSTEM

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Over the past 25 years the white seabass, *Atractoscion nobilis*, has been propagated in open and semi-closed seawater systems prior to being released as a means to replenish the native population of this ecologically and commercially important fish. This study examines the feasibility of, and baseline parameters necessary for, growing white seabass in a fully closed recirculating system. Juvenile white seabass were obtained from Hubbs-Seaworld Research Institute (HSWRI) and held for 90 days in a 1,400L circular, polyethylene plastic pool containing artificially mixed saltwater. Water flow, water chemistry, system design, light conditions, seawater composition, fish behavior, feeding rate, growth rate, stocking density, and animal stresses were documented. The fish were held at an average temperature of 19°C. Other than water chemistry and lighting, the conditions and behaviors for the fish were very similar to that of the HSWRI hatchery systems. Throughout the study, the main discrepancies occurring in an artificial environment rather than in a natural environment were periods of high nitrate and nitrite levels, fish eating behavior, and color changes in the fish based on lighting. At the end of the 90 day trial period, 91% of 22 fish survived. Loss of 9% of the animals is within the range of acceptable losses that occur in typical white seabass culture systems, especially when transport is included. While this study documents the feasibility and baseline parameters necessary for the propagation of white seabass in a fully closed system, additional experimentation is needed to optimize fish performance.

78. COMPARING THE FREQUENCY OF POLYANDRY BETWEEN TWO POPULATIONS OF BROWN SMOOTHHOUND SHARK (*MUSTELUS HENLEI*)

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Polyandry (i.e., multiply mating females) has been documented in several shark species and may affect the effective population size by reducing male reproductive success. Polyandry was recently detected in a population of the brown smoothhound shark, *Mustelus henlei,* from Las Barrancas, Mexico with litters demonstrating the greatest percentage of multiple paternity for any shark species (0.93 of litters and avg. number of sires = 2.3). To determine if this frequency is consistent throughout the species' range, six polymorphic microsatellite markers were used to determine the frequency of multiple paternity in 12 litters (avg. pups = 6.9) of *M. henlei* from Santa Catalina Island, CA. Multiple paternity was detected in 0.33 of litters from this population with an average of 1.3 sires per litter. Although polyandry was detected in this

study, the frequency of occurrence is much lower than that observed in the Mexican population and is more similar to that observed in the spiny dogfish, *Squalus acanthias* (0.3 of litters and avg. number of sires = 1.3).

79. THE LIFE HISTORY AND ECOLOGY OF CALIFORNIA CORBINA, *MENTICIRRHUS UNDULATUS*

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California corbina, *Menticirrhus undulatus*, are a common but poorly understood species of croaker found in the surf zone from the Gulf of California to Point Conception, California. While protected from commercial fishing since 1915, corbina are the target of a robust recreational fishery and are considered a prized catch by surf and pier anglers. In order to understand the ecology and life history patterns of this largely unstudied species, 6,051 California corbina were collected in beach seines and experimental gillnets from 1995 to 2010. Sagittal otolith-based age analyses revealed fish up to 10.5 years old and demonstrated significantly faster and larger growth by females of the species. Von Bertalanffy growth parameters were $L_\infty = 345.0$, $k = 0.25$, and $t_0 = -1.243$ (n = 170) for males and $L_\infty = 630.1$, $k = 0.11$, and $t_0 = -1.539$ (n = 354) for females. Standard length and weight varied according to the following power function: Weight = $10^{-5}(SL)^{2.956}$. Both sexes reach 50% maturity by their first year, at approximately 100 mm SL. Gonadosomatic indices peaked in June and August (females, 5.98%; males, 6.55%), suggesting that spawning may occur during the spring and summer. Gillnet catch-per-unit-effort varied significantly between sites spread across southern California, with Seal Beach and Oceanside as the most populous sites surveyed. Highest catch-per-unit effort values were seen in 1995 and declined until the end of the gillnet sampling in 2008. No correlation was found between annual or monthly CPUE and sea surface temperature for this time period.

80. ROLE OF TEMPERATURE IN THE INFECTION RATE OF *EUHAPLORCHIS CALIFORNIENSIS* IN THE CALIFORNIA KILLIFISH FUNDULUS PARVIPINNIS

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Parasite development and transmission can be strongly influenced by abiotic factors, especially temperature. Dispersal stages in the life cycle of trematodes, like cercariae, can be directly affected by temperature. Although several studies have addressed the effect of increasing temperature on trematode biology, our understanding of the effects of environmental factors on host-parasite systems in marine ecosystems is still limited. We used the host-parasite system of *Fundulus parvipinnis* and *Euhaplorchis californiensis* to examine the effect of temperature on the transmission rate of juvenile trematodes to their second intermediate fish host. The California killifish is common in the estuaries and salt marshes of Southern California and is host to many trematode species including *E. californiensis*. We predicted that as temperature increased the rate of transmission of *E. californiensis* to *F. parvipinnis* would also increase. Cercarial stages of *E. californiensis* were obtained from their first intermediate host, the California Horn Snail *Cerithidea* californica. Fish were experimentally infected with this parasite at four different temperatures, 10, 20, 30, and 35°C. Parasite intensity was determined upon dissection of the fish host. Our results suggest that with future climate changes and subsequent temperature increases that the abundance of *E. californiensis* in the California killifish will increase.

81. *CONUS TEXTILE* VENOM DUCT MORPHOLOGY

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Cone snails are a group of predatory gastropods which paralyze their prey (worms, snails and fish) by using a modified radular tooth to inject a venom. The venom is a complex mixture produced in a duct with a bulb at one end and an opening into the esophagus at the other. In our study, we examined the morphology of the venom duct in *Conus textile*, a snail hunter, using light and transmission electron microscopy. Two snails were used and in both animals, the venom duct was divided into eight sections of equal length. The

duct is covered by a xxx epithelium which lines a layer of muscles separated into circular and oblique. The lumen is lined by a simple cuboidal to columnar epithelium. The morphology of the epithelial cells in each section was examined and compared between the two snails' corresponding regions. The cell morphology varied between both specimens suggesting that the cells undergo a wave of maturation along the length of the duct and each snail was caught when equivalent sections of their ducts were at different stages. We propose a cycle of 1) synthesis of venom granules resulting in elongation of the cells, 2) secretion of the granules into and often filling the duct lumen, and 3) retraction of the epithelial cells along the basal lamina. It is hoped that this morphological detail will assist in the biochemical characterization of the venom produced in each region which is currently being investigated by the lab of Dr. Schulz at Occidental College.

82. THE EFFECTS OF PRECIPITATION AND STORM DRAIN RUNOFF ON URCHINS AND FISH AT PALOS VERDES PENINSULA

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Palos Verdes Peninsula forms the southern portion of Santa Monica Bay and is included in the Los Angeles watershed. This watershed is almost entirely urbanized consisting of paved surfaces that bring anthropogenic runoff directly to the coastline through a series of storm drains. This runoff, which is exacerbated after large rain events, can include contaminants from many non-point sources. The effects of this storm drain runoff on marine organisms living offshore of the Palos Verdes Peninsula is largely unknown. In this study, we seek to determine the relationship between storm drain proximity and populations of Strongylocentrotus purpatus (purple sea urchins). Additionally, we determined species richness and diversity of fish populations in the same area. The locations of storm drains and aerial extent of nearshore urchin barrens have been mapped out using Google Earth. Precipitation data from the Los Angeles Department of Public Works has been compiled to determine the immediate response of both fish and urchins to an increase in runoff. Our results showed an increase in urchin density per meter in areas closer to the storm drains, as well as a decrease in fish abundance at sites closer to drains.

83. SATELLITE OBSERVATIONS OF CHLOROPHYLL DYNAMICS IN THE SOUTHERN CALIFORNIA BIGHT

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A long-term time series of MODIS data are used to investigate chlorophyll dynamics in the Southern California Bight. In addition to the annual variations expected in temperate seas, we look for influences of the Channel Islands and episodic events, such as Santa Ana winds. For Santa Monica Bay, an intermittent secondary maximum is found to occur September to October. The relation between winds, SST and chlorophyll for this secondary maximum is explored.

84. BEACH BACTERIA, KELP WRACK, AND ECOLOGICAL HEALTH

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Water quality along the coast has long been a concern for human health, and swimming areas receive Beach Report Cards based on bacterial counts in the water. However, little is known about how these bacteria may affect ecological health of animals on the shore. This study examines the health of embryos of the California Grunion *Leuresthes tenuis* that incubate buried in sand for up to two weeks. The first hypothesis is that eggs of the California Grunion incubated on beaches that receive F grades will have lower rates of hatching success than eggs incubated on A or A+ graded beaches. We chose beaches located in the Malibu area, at Malibu Lagoon and Topanga State Beaches. We found no difference in hatching rates between the beaches. Instead, both beaches had a mixture of healthy and unhealthy clutches. To follow up, we hypothesized that the persistence of bacteria on the beaches may result from the combination of both outfall effects and the presence of kelp wrack. In an ongoing study we show that bacteria grow significantly more densely on kelp wrack that is continuously wet with nutrient enriched water, than either kelp wrack that is kept wet with pure water, or kelp wrack that dries out.

85. DEMOGRAPHY OF ANTHROPOGENIC EFFECTS IN STRANDING RECORDS FOR CALIFORNIA SEA LIONS, 1983–2006

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California sea lion (*Zalophus californianus*) populations have increased over the last 30 years, as have levels of federal and state protection. During this time, 14% of all reported California sea lion stranding events were associated with human related injuries and interactions, henceforth termed anthropogenic effects. This study addresses stranding events with obvious anthropogenic causes among *Z. californianus* within California from 1983 to 2006, as well as the total number and variety of anthropogenic effects incurred. Anthropogenic effects include non-lethal harassment, exposure to oil/tar, and stranding in close proximity to people, as well as mortality due to boat collisions, entrainment in power plants, shootings, entanglement with marine debris, fishing related incidents, vandalism, and non-shooting weaponry assault. During this period, for the 3,784 such stranding events, demographic and temporal variation exists within the stranding records, with the highest frequency occurring among juvenile males, during summer months, and during El Niño years. For the 3,856 total observed anthropogenic effects, similar temporal variation exists; for the three most frequently occurring anthropogenic effects (proximity, fishing related incidences, and shootings), the annual variability differed while monthly variability remained similar. Despite the associated higher frequency of fishing related incidents and shootings during El Niño years, no relationship was found between El Niño years and the number of occurrences of these anthropogenic effects, suggesting limited influence of environmental conditions over the types of anthropogenic effects incurred by California sea lions.

86. EFFECTS OF OYSTER RESTORATION TECHNIQUES ON OLYMPIA OYSTER (*OSTREA LURIDA*) DENSITY, MUSSEL DENSITY, AND SHELL LOSS IN NEWPORT BAY, CA

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Oysters are important bivalves in estuarine ecosystems because they provide habitat for other animals, stabilize sediments, and may improve water quality. We examined which of several restoration techniques would be most effective for restoring the Olympia oyster, *Ostrea lurida*, in Newport Bay, CA by constructing replicate (n=5) 2 m × 2 m shell beds of 4 treatment types of two thicknesses (4 cm versus 12 cm) and two levels of consolidation (bagged versus loose shell). We hypothesized that thick oyster beds would show the greatest increase in oyster density, and would lose less shell % cover; but level of consolidation would not have any effect. We analyzed shell loss and densities of oysters and mussels that colonized the beds after 1 year by removing all shell in a 25 cm × 25 cm area of each oyster bed, sorting out all live bivalves, and identifying each to species. There was no significant difference in the density of *Ostrea lurida* adults among treatments, but there was a dramatic increase in density relative to control plots. *Ostrea lurida* settler and non-native *Musculista senhousia* densities were greatest on thick, bagged plots; *Mytilus galloprovincialus* density was greatest, and shell loss was less, on 12 cm thick plots. Thick, loose shell plots appear to maximize oyster success while minimizing shell loss and non-native success.

87. DENSITIES AND HABITAT DISTRIBUTIONS OF TWO OYSTER SPECIES IN ALAMITOS BAY AND NEWPORT BAY, CALIFORNIA

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Several recent studies have found that man-made substrata in marine habitats harbor a higher ratio of non-native to native species compared to natural substrata. Alamitos Bay, CA is a highly urbanized area with little natural substrata available as habitat for sessile organisms. Alamitos Bay urbanization could affect distributional patterns of California's only native oyster, *Ostrea lurida*, and the non-native Japanese oyster, *Crassostrea gigas,* especially compared to nearby Newport Bay which has more natural substrata available as habitat. We explored whether there were differences in the densities of each species in the two bays and whether their distributions on natural versus human-introduced habitat types differed. We randomly placed replicate 0.25 m^2 quadrats (n=20–30) and used point-contact techniques to quantify percent cover of each

habitat type and then counted oysters within quadrats to calculate densities at each site. Suitable hard substrata were available at all sites in both bays implying that habitat availability does not constrain oyster abundances for either species. However, *Ostrea lurida* density was 5.4 times greater in Newport Bay than Alamitos Bay and native oysters were always more abundant than *C. gigas* in both bays at all sites. The proportion of non-natives to total oysters was relatively invariant in Alamitos Bay but higher on human-introduced versus natural habitats in Newport Bay. Conservation efforts to restore native oysters in Alamitos Bay may be beneficial for increasing the relative abundance of *O. lurida* relative to non-native *C. gigas*.

88. DETERMINING THE RELATIVE INFLUENCE OF THE METAL POLLUTANTS IN THE NEWPORT AND LAGUNA BEACH SEAWATER ON THE GIANT KELP POPULATIONS OF CRYSTAL COVE STATE PARK BY ANALYSIS OF SIEVE TUBE SAP METALS

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One of the most rapid, consistent, and cost effective ways to measure water quality is to analyze Sieve Tube Sap (STS) from *Macrocystis pyrifera* (the giant kelp) using an inductively coupled plasma-mass spectrometer (ICP-MS). This analysis reveals which bioavailable metals are present in the waters surrounding the kelp beds being sampled. We used this technique to analyze kelp taken from the mouth of Newport Harbor, an area known to be contaminated with many metals (particularly those related to boating), Laguna Beach near a sewage outfall and river mouth, and within Crystal Cove State Park (CCSP). This allowed for the identification of a unique chemical signature for both of these locations to determine if one or both of these two point sources of pollution are able to contaminate CCSP's protected waters (a Marine Protected Area). Kelp in CCSP showed an influence from both locations, with results being highly variable between seasons, and metals associated with boating from from Newport Harbor impacting the kelp beds the most consistently. Furthermore, certain groups of metals appeared always in tandem, and correlated with various environmental events (e.g. upwelling, rainfall, etc.). The results will serve as a case study in the effectiveness of MPAs in increasing water quality, as well as improve our understanding of the range of metal pollutants in coastal habitats and their incorporation into aquatic ecosystems.

89. POST-STATION FIRE DEBRIS FLOW ANALYSIS IN THE SAN GABRIEL MOUNTAINS

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To comprehend burn area to debris flow relationships and denudation rates due to debris flows, we have characterized the occurrence, spatial density, and characteristics of the 2010 debris flows subsequent to the 2009 Station Fire in the southwestern San Gabriel Mountains. Burn area debris flows are abrupt and destructive; by differentiating these flows, we will develop a prediction model of future post fire debris flows and calculate denudation rates due to these flows. Preliminary GIS mapping of debris flows, area calculations, and spatial density demonstrate that most debris flows initiate from undisturbed hillslopes, cover an average area of 79,770 m^2, have a spatial density of 1 flow/2 km^2, have extensive deposition volumes (totaling 140,339 m^3), and a denudation rate of 3 cm/yr from debris flow events. Continued field sampling will document flow more deposition volumes and lithology. Our new data on spatial density, lithologic characteristics, and deposition volumes of recent burn area debris flows provides an empirical dataset to use in future debris flow hazard analysis and will be useful for models considering debris flow mechanics, as well as giving denudation rates due to these types of debris flows.

90. RIDGE TO REEF ASSESSMENT OF METAL CONCENTRATION AND MINERALOGY IN ROCKS AND SEDIMENTS ON ST. JOHN, U.S. VIRGIN ISLANDS

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Development around the island of St. John has increased terrigenous (land derived) sedimentation in coastal bays with coral reefs. Hydrothermally altered bedrock in the watersheds contributes metal-rich sediment to ephemeral streams and bays around St. John. In order to determine if land-based sedimentation

is affecting sensitive benthic reef environments we have compared the chemistry and mineralogy among bay sediment (reef and shore), and watershed sediment and bedrock. Our objectives are to determine how the distribution of metal concentrations and mineralogy change as bedrock and sediment are eroded from the ridge and transported to reefs and how much terrigenous derived metals are present at fringing reefs. Major and trace element concentrations of rock and sediments were measured using X-ray fluorescence. Mineralogy was determined through analysis of 35 sediment and rock thin sections. The watershed bedrock, Water Island Formation, is composed of two units, plagiorhyolite and basalt. An examination of plagiorhyolite thin sections showed quartz and plagioclase phenocrysts in an aphanitic ground mass composed of quartz and plagioclase with secondary chlorite alteration. The basalt was spilitic in composition and thin sections revealed a fine-grained matrix composed of plagioclase, clinopyroxene, epidote, chlorite, and opaque minerals. Major and trace elements that derive from terrigenous sources are present at fringing reef sites in Coral Bay and Great Lameshur Bay. Higher concentrations of terrestrial derived metals (Al, Ti, Ba, Cu, Zr, Zn) are detected below developed watersheds compared to undeveloped. These data support previous research showing higher fractions of terrigenous sediment on reefs in developed bays.

91. SOIL CARBON STORAGE IN SOUTHERN CALIFORNIA SALT MARSHES: THE ROLE OF PLANT COMMUNITIES AND ECOSYSTEM RESTORATION

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Atmospheric concentrations of carbon dioxide ([CO_2]) have increased from pre-industrial levels of ~280 ppm to current levels exceeding 379 ppm. Among the many options for mitigating the impacts of this rise in [CO_2] is the capture and storage of CO_2 in long-lived ecosystem carbon pools including biomass or soil organic matter. The potential to sequester carbon in vegetated coastal ecosystems (i.e., "blue carbon"), including salt marshes, is particularly appealing in this context because of their potential to accumulate large amounts of soil organic carbon while releasing small amounts of the potent greenhouse gas methane (CH_4). We conducted two studies in Southern California salt marshes to explore the controls of soil organic carbon accumulation and to quantify the flux of CH_4 from these ecosystems to the atmosphere. In the first study, we assessed the importance of plant community on soil carbon storage in Newport Bay. In the second study, we explored carbon storage in wetlands that had been restored for 2 or 22 years to test the hypothesis that soil organic carbon accumulates following ecosystem restoration. We demonstrated that plant community type can be an important factor influencing soil carbon storage in Southern California wetlands and that contrary to our initial hypothesis, soil organic carbon does not always accumulate following wetland restoration. The results of these studies have important implications for attempting to maximize carbon sequestration with wetland management projects.

92. TEASING APART THE PATHWAYS AND MECHANISMS OF SHORE DRIFT EFFECTS ON ISLAND FOOD WEBS IN BAHÍA DE LOS ÁNGELES, BAJA CALIFORNIA, MEXICO

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The islands of Bahía de los Ángeles are some of the driest habitats on earth, yet they are able to sustain a high density of terrestrial life due to allochthonous inputs from the adjacent and highly productive Gulf of California. Previous studies have shown that marine inputs are important to terrestrial food webs, but the specific pathways are not well understood. By using a carbon isotope (13C) to enrich naturally occurring algae, we can learn more about the various pathways by which marine inputs are entering, and thus sustaining, island food webs. In the summer of 2011, *Sargassum* algae was collected and soaked in a Carbon-13 solution for three days, then placed on the shoreline of Coronado Island. Terrestrial invertebrates were collected using pitfall traps placed along three transects, which extended from the experimental algae to 200 meters inland. Although isotopic analysis showed the algae did not take up the labeled Carbon, quantitative population data showed that there was an increase in diversity and abundance of organisms found closer to the shoreline, with 46% of organisms collected coming from within 25 meters of the experimental algae. In the summer of 2012,

adjustments will be made including the use of Nitrogen-15 and an added focus on sampling higher tropic levels, including mammals and reptiles, in order to determine their impact on the movement of energy between the two ecosystems. Results of this research will provide us a better understanding of the trophic connections between these two distinct habitats, ultimately improving our ability to conserve them.

93. BENTHIC COMMUNITY STRUCTURE IN TALBERT MARSH TWENTY YEARS POST-RESTORATION

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Before human activity transformed the Huntington Beach Wetlands into its current state, the Huntington Beach and Newport Beach wetland systems were connected by the Santa Ana River. However, beginning in the 1920's, the tidal connections began to be filled until the tidal influence was completely removed from the wetland system. In 1987, the California State Coastal Conservancy provided a grant to implement a restoration plan for Talbert Marsh, which is a portion of the Huntington Beach Wetland system located near the mouth of the Santa Ana River. The goal of the project was to restore Talbert Marsh to a fully functioning, viable and biologically diverse tidal salt marsh. Restoration began in 1988 and tidal flushing to Talbert Marsh was restored in 1989. Most studies assess the structural aspects of salt marsh restoration over short time scales; however, the overall aim of our research is to assess whether or not the function has been restored to the marsh over long time scales. In this portion of the project, we will be comparing structural metrics from pre-restoration (1988) to 20 years post-restoration. Pre-restoration studies showed that there was low species diversity, and the majority of invertebrates found were polychaetes. Twenty years post-restoration, data collected in 2008 and 2009 show that the diversity of benthic, invertebrate species has dramatically increased from 1988 and 1989, and polychaete dominance has decreased. This twenty year long-term study is potentially an important reference for assessing and comparing future salt marsh restorations.

94. A NEW METHOD FOR IN-SITU MEASUREMENTS OF STEM HYDRAULIC CONDUCTANCE IN INTACT PLANTS

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Hydraulic conductivity of plant stems is a key trait of the hydraulic architecture of plants, with high hydraulic conductivity typically being associated with high rates of stomatal conductance, transpiration, and photosynthesis. In addition, measurements of hydraulic stem conductance are essential for standard methods in plant hydraulics research to document the abundance of embolisms in xylem. This is needed for xylem vulnerability curves, i.e. the relationship between stem water potential and the percent loss of conductance, and for documenting embolism formation and repair in plants. The main drawback of hydraulic methods to measure embolisms has been that they are destructive and labor-intensive. The objective of this research was to develop an in-situ system to log hydraulic stem conductance in intact plants in the field for an extended period of time (days to weeks).

The new in-situ hydraulic conductance measurement system consists of two temperature-corrected stem psychrometers for determining the pressure differential and a sap flow gage that uses the stem heat balance method for measuring volumetric sap flow. One stem psychrometer is mounted either on a leaf or on a terminal branch and the other stem psychrometer is mounted near the base of the plant, with the sap flow gage mounted on a suitable stem between the two psychrometers. The new *in-situ* system was tested successfully on both potted and free-growing plants of *Malosma laurina* (Anacardiaceae), a chaparral shrub from southern California. Hydraulic conductance declined with decreasing water potentials, indicating the formation of xylem embolisms.

95. SEASONAL PATTERNS OF NOCTURNAL TRANSPIRATION IN ADULTS AND POST-FIRE RESPROUTS OF *JUGLANS CALIFORNICA* AND *QUERCUS AGRIFOLIA*

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Seasonal patterns of nocturnal transpiration (E_{night}), which may provide insight into function, have been little studied. Proposed explanations for E_{night} include increased mineral nutrition, vessel refilling, and stomatal flaws. We examined day and nighttime E in adults and post-fire basal resprouts of the deciduous southern California black walnut (*Juglans californica*) and evergreen coast live oak (*Quercus agrifolia*). We hypothesized that resprouts would have higher E than adults, and that E_{night} would correlate positively with water potential (Ψ). Day and nighttime leaf Ψ, %RH, temperature, and stomatal conductance (g_s) as a direct indicator of E were measured from Nov. 2010–Apr. 2012. Mean day and nighttime g_s were significantly greater in *Q. agrifolia* than *J. californica*. Within species resprouts had higher mean day and nighttime g_s and Ψ than adults, but differences were insignificant, indicating a transition of resprouts to adult physiology. Contrary to predictions, there was no consistent correlation between nighttime g_s and Ψ. Nighttime g_s showed extreme seasonal variation. Maximum values occurred in Jan. of 2011 and 2012, and coincided with new leaf/flower growth; this repeatability may indicate a seasonal pattern. High g_s and subsequent values of zero measured for the same leaves, and minimal nighttime g_s at low water Ψ and in summer suggest that faulty stomata or vessel refilling are not likely the primary reason for increases in E_{night}. The possibility of increased mineral nutrition for new growth warrants further study. Seasonal variation of E_{night} may play a role in plant water budgets and growth patterns.

96. THE ROLE OF SAPWOOD CAPACITANCE IN HYDRAULIC STRATEGIES OF DESERT CHAPARRAL SHRUBS

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Desert chaparral shrublands occurring at the transition zone between the lower slopes of the San Bernardino Mountains and the Mojave Desert are comprised of species that utilize various strategies in response to drought. The variable species-specific response of the shrubs to water availability is a result of tradeoffs between rooting depth, phenology, and vulnerability of xylem to cavitation. We investigated a component of the hydraulic architecture, hydraulic capacitance of sapwood, in order to help determine the dynamics of water movement through shrubs. To quantify this, we collected stem samples from 16 woody shrub species at Morongo Valley. The relative water content and the water potential of debarked stem samples generated by dehydration were determined using a four point balance and a thermocouple psychrometer, respectively. The seasonal minimum and maximum non-transpiring water potential measurements were also collected. Furthermore, we determined the water potential at 50% loss of hydraulic conductivity (P50), a measure of vulnerability to drought-induced xylem cavitation. Results indicated that P50 and density is negatively correlated with capacitance. Furthermore, capacitance corresponds to the differential drought strategies exhibited by the plants.

97. EFFECT OF MALE DENSITY AND PROXIMITY ON SEED PRODUCTION IN THE DIOECIOUS PLANT *ATRIPLEX HYMENELYTRA*

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A variety of ecological factors can influence the production of seeds by plants. Among dioecious species where pollen generators (males) and seed producers (females) are separate individuals and pollen is wind-dispersed, the density and proximity of males relative to females may be particularly important in determining pollination success and subsequent seed set. We investigated the potential effect of male density and abundance on the production of seeds in the dioecious species *Atriplex hymenelytra*, a common desert shrub in which females produce bracts (fruits) that under optimal conditions each contain a single seed. At study sites in the Mojave National Preserve, the spatial distribution of all males within a 10-meter radius of each of 10 females was determined using a handheld Global Positioning System (GPS) and all bracts produced by each female were collected over the 2009 reproductive season. Bracts were counted and a subset examined for the presence of fully formed seeds. Preliminary findings are suggestive of a direct relationship between male density and seed set, and inverse relationship between distance to nearest male and seed quantity. Results from studies such as these may be valuable to the development of

management plans for small or declining populations of dioecious species where gender rarity could have significant impacts on survival.

98. EFFECTS OF CAFFEINE ON INHIBITION OF CUCUMBER (*CUCUMIS SATIVUS*) SEED GERMINATION, GROWTH SUPPRESSION, AND ITS INTERACTION WITH GIBBERELLINS

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Caffeine can be found in different quantities in tissues of some plants such as *Coffee arabica* and *Theobroma cacao*. Caffeine is allelopathic, reducing competition by inhibiting seed germination of other nearby plants. Almost one hundred years ago caffeine was shown to inhibit germination of several plant species, though the mechanism of action of caffeine is still unknown. Through our initial studies in sterile plant tissue culture, we showed that caffeine effectively delayed or prevented (depending on the concentration) seed germination of cucumber (*C sativus*) seeds. Further studies on cucumber seed germination were performed where we tested various concentrations of caffeine for prevention or suppression of *C.sativus* seeds' germination using wet filter paper **(Phase I study).** Secondly, caffeine's ability to prevent imbibition of water was analyzed **(Phase II study).** Thirdly, in order to determine if caffeine mimics Abscisic acid (ABA) in maintaining dormancy (preventing germination), seeds were pre-treated with Gibberellic acid (GA) prior to caffeine and/or ABA treatment and germination observed **(Phase III study).** Lastly, amylase assays were performed to determine if caffeine inhibits germination through suppression or inactivation of the amylase enzyme **(Phase IV study).** Allelopathy is complex and the inhibitory effects of caffeine on *C.sativus* as well as other agricultural crops needs to be documented to support its effectiveness as a "natural" weed suppression agent.

99. UNDERSTANDING LEAF HYDRAULICS IN TANK BROMELIADS BY INHIBITING AQUAPORINS

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Tank bromeliads are intriguing model organisms for studying how plant leaves manage their water supply, as they absorb, transport, and transpire water entirely through their leaves. The primary goal of this study is to better understand how water movement through leaves is regulated in *Aechmea nudicaulis*, a CAM tank bromeliad that grows in the neotropical rainforest canopy. Experiments have been conducted to determine overall rates of transpiration and leaf hydraulic conductivity, and anatomical investigations are underway to provide data needed to model water flow in leaves of *A. nudicaulis*. Because aquaporins (protein channels in cell membranes) are known to influence water uptake and hydraulic conductivity in roots as well as hydraulic conductivity in leaves, I measured plant water uptake with and without the addition of a known aquaporin inhibitor, mercuric chloride. I filled the tanks of six plants with a 50 μM solution of mercuric chloride in spring water and six with only spring water, and measured plant weight loss daily for six days; all plants were grown in a growth chamber under controlled conditions. Plants with mercuric chloride transpired significantly less over the six-day period (t-test; $P = 0.03$). These data, along with measurements of vascular bundles made from leaf clearings and leaf cross-sections, will be used to help provide input necessary for a mathematical model of leaf hydraulic conductivity that can be applied to *A. nudicaulis* as well as other species.

100. QUANTIFICATION OF WATER UPTAKE FROM PULSED INPUT VIA DISTURBED AND UNDISTURBED CHANNELS ON A DESERT BAJADA

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Sap-flow gauges were used on *Larrea tridentata* to provide automated and efficient long-term measurements after simulating rain events (pulses) at three sites on the foot of the Providence Mountains in the Mojave Desert: an upslope channel with natural flow (active channel), a channel below a road with

interrupted flow (inactive channel), and an upslope area without a channel (simulated channel). Plants within 3 meters of the active channel had a 20% sap-flow increase showing a maximum peak 16 days after pulse; whereas plants from inactive channel had a 45% sap-flow increase with a maximum peak 8 days after pulse. For plants in the simulated channel, only plants within 1 meter responded to pulse with a 20% sap-flow increase and a maximum peak 15 days after pulse. Plants located further than 3 meters from a channel did not respond to the pulses in any of the three sites. As opposed to expected results, plants located within 3 meters of the inactive channel did respond to the water pulse, and surprisingly showed higher percent increases in sap-flow, however, these values did not persist as in the case observed in the active and the simulated channels. It is not clear why plants near channels that have been cut off from significant flow for greater than 100 years would have a more pronounced pulse response, but the inability to sustain these higher rates may indicate a more surficial root distribution within the substrata influenced by the channel.

101. PREDICTING THE WATER CONTENT OF *LARREA TRIDENTATA* USING SPECTRAL INDICES

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Analyzing leaf optical properties has become a useful method for measuring plant physiological status. The measurements become fast and affordable when coupled with remote sensing, but must first be tested for accuracy on the species of interest. In this study, I examined the correlation between spectral water indices and the leaf water content of the desert shrub, *Larrea tridentata*. Seven *Larrea* shrubs were deprived of water in the CSUF greenhouse for 59 days.

Leaf-level reflectance measurements were taken periodically as *Larrea* shrubs desiccated. Four spectral indices were determined from the reflectance data: the water index (WI), the normalized difference vegetation index (NDVI), the normalized water index (nWI) and the structure independent pigment index (SIPI). Index values were compared to measurements of leaf relative water content (RWC) and equivalent water thickness (EWT) to determine how well these indices predict plant water status. WI and NDVI showed a linear relationship with both RWC and EWT. Both indices showed a slightly stronger correlation with EWT than RWC, however the correlation is still relatively weak. This study shows that there is a correlation between leaf reflectance and the water status of *Larrea tridentata*, but the indices may only be valuable when looking at large differences in water content.

102. TESTING FOR EMBOLISM REPAIR IN VALENCIA ORANGE

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Because plants normally transport water under negative pressure, air can be drawn into the plants' hydraulic systems, the xylem if there is a shortage of water in the soil. As air is drawn into xylem conduits through small pores, called pit membranes; embolisms are formed and can impede water flow that can lead to branch and leaf mortality. The objective of my research is to test for formation and repair of embolisms in Valencia Orange (*Citrus* × *sinensis*). In the past, it was thought that embolism repair can only take place in the absence of transpiration and at high water availability. Recent studies have shown that embolisms can be repaired during transpiration and under strong negative pressure in the xylem. The null hypothesis to be tested in this research is that embolism repair in Valencia Orange occurs only at night during minimal transpiration and high water potential. Three 24 hours experiments are conducted to measure the degree of embolism formation and repair in fall 2011 and in mid spring and early summer in 2012, using trees on campus. The physiological conditions under which embolisms form and/or are repaired are documented by measurements of leaf stomatal conductance and branch pressure potentials. Result from fall 2011 and spring 2012 indicated that Valencia Orange trees did not form or repair embolisms at that time. Measurements will be repeated in summer 2012 to see if embolism repair occurs during warmer seasons.

103. MITOCHONDRIAL PHYLOGEOGRAPHY OF THE GECKO GENUS *CNEMASPIS*

F.F. Tarzi, C. Remigio, V.F. Tarzi, R. Nance, Z. Travis, J. Grismer, L. Grismer, and L.F. Greer. Genomics and Molecular Research Group, La Sierra University, Department of Biology, Riverside, CA, 92505.

Cnemaspis is a large genus of geckoes with 50 species endemic to Southeast Asia. Geckos are distinctive reptiles from an ancient family of lizards (Gekkonidae) of several thousand species worldwide. Their distinctive characteristics include big circular pupils, long toes, unique chirping vocalizations, and feet with close-set ridges or setae, which permits them to adhere to almost any surface. In this study, the mitochondrial gene encoding NADH dehydrogenase subunit 2 (*ND2*) was sequenced from populations surrounding the South China Sea. Phylogenetic analyses of these sequences recovered five major lineages, including one new species, reflecting the radiation and dispersal of this ancient genus across this region during many sea level changes and putative geographic range variations. In addition, the nuclear gene *Rag1* is in the process of sequencing and analyses.

104. PHYLOGEOGRAPHIC ANALYSIS OF THE SPECIATION OF CYRTODACTYLUS INTERMEDIUS LIZARDS

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Cyrtodactylus is the largest gekkonid genus known. Geckos are distinctive reptiles from an ancient family of lizards (Gekkonidae) of several thousand species worldwide.Phylogenetic analyses of sequences of the mitochondrial genes encoding *cytochrome B* and NADH dehydrogenase subunit 2 NADH dehydrogenase (*ND2*), obtained from South East Asian specimens that are classified as *Cyrtodactylus intermedius* suggest that putative new species within this complex have emerged through allopatric speciation. These populations were isolated on limestone karsts and islands as sea levels rose leading to the subsequent partial submerging of mountains leaving island refugia in the Cardamom mountain chain near the close of the Pleistocene. Our analyses of gene sequences of populations from seven separate collection sites suggest divergent sequence variations consistent with geographic isolation of populations.

105. PHYLOGENETIC POSITION OF THE PIT VIPER *CRYPTELYTROPS HONSONENSIS*

F.F. Tarzi, R. Bahnam, V.F. Tarzi, J.R. Wood, L. Grismer, and L.F. Greer. Genomics and Molecular Research Group, La Sierra University, Department of Biology, Riverside, CA, 92505.

Cryptelytrops is a genus of pit vipers that contains 13 species. About 7 of these are endemic to southern Asia—India, Bangladesh, the Andaman Islands, and Indochina. Genomic DNA was extracted from tissues of two specimens of the recently described species *Cryptelytrops honsonensis*. In addition to specimens from several other populations of yet to be described species. Tissues from *C. honsonensis* were obtained from Hon Son Island in Rach Gia Bay, Kien Giang province of southern Vietnam. The mitochondrial *ND4* genes was amplified and then sequenced. Multiple alignments of the sequences were constructed in preparation for phylogenetic analyses using maximum likelihood (ML) and Bayesian inference algorithms. Our data analyses show, with strong ML bootstrap support and high Bayesian posterior probabilities, that *Cryptelytrops honsensis* is a closely related sister taxon to *C. macrops* but more distantly related to sister taxa *C. kanburiensis* and the combined *C. cardamomensis / venustus* subclade. Our analyses also compared the position of *C. honsonensis* with other related pit viper taxa.

106. MTDNA PHYLOGENY OF SE ASIAN VINE SNAKE SPECIES OF THE COLUBRID GENUS AHAETULLA

Vian Tarzi, Fawaz Tarzi, Caitlin Miller, Jennifer Burns, Perry Wood, L. Lee Grismer, and Lee F. Greer. Greer Research Group, La Sierra University, Department of Biology, Riverside, CA, 92505.

Ahaetulla is a southeastern Asian genus of eight vine snakes Species. Species of these reptiles are mildly venomous and are characterized by their long, thin bodies, and pointed snout. Populations from Malaysia and Cambodia were sequenced for mitochondrial gene *cytochrome B* (*cytB*). Four species of the genus, *Ahaetulla prasina, mycterizans, nasuta*, and *fasciolata*, have very similar morphological features. Phylogenetic analysis using maximum likelihood and Bayesian inference algorithms of sequences revealed four major, strongly supported clades with biogeographical distributions suggestive that these species have diverged *via* allopatric speciation.

107. MITICHONDRIAL BIOGEOGRAPHY OF HUMAN ANCIENT DNA FROM 3,000 YEAR OLD BONES FOUND IN TAL AL' UMAYRI (JORDAN)

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Archaeologists in Tall al' Umayri, Jordan, discovered human bone fragments in a destruction layer containing at least four human individuals (two adults, one adolescent and one child). This layer was dated by artifacts to the Late Bronze / Early Iron I period (13^{th} century BCE). ^{14}C dating on two samples from one arm bone supported the dating, placing the bones between 2940 ± 15 and 2930 ± 15 calibrated years before present (BP) for each sample. Ancient DNA (aDNA) was extracted and mitochondrial DNA (mtDNA) amplified from three individuals (adult male jaw bone, an adult tooth, and bone fragment). Nuclear DNA amplification was attempted but unsuccessful. Amplified mtDNA from the first (HRVI) and second (HRVII) mtDNA hypervariable regions was sequenced and aligned against multiple human mtDNA sequences including *Homo sapiens sapiens* (human Cambridge Reference Sequence, CRS), *Homo sapiens neanderthalensis*, and the Denisovan hominin. Analysis of informative polymorphisms show haplotype markers associated with peoples of the Middle East, North Africa and some Europeans emerging within the L3 major haplogroup complex. No two of the three individuals clustered within the same haplogroups, indicating that these three individuals were not members of the same nuclear family. A wide variety of Mediterranean haplogroup markers were observed among the specimens, which is consistent with migratory intermixing expected from upheavals known to have occurred in the Eastern Mediterranean of the 13^{th} century BCE.

108. UNCOVERING A FOSSORIAL SPECIES: HOME RANGE AND HABITAT PREFERENCE OF THE WESTERN SPADEFOOT TOAD (*SPEA HAMMONDII*) IN ORANGE COUNTY PROTECTED AREAS

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The western spadefoot toad (*Spea hammondii*) is a small, burrowing amphibian that inhabits arid ecosystems in California and Baja California. The species lives underground during the dry season and emerges only after a certain amount of rainfall to make its way to vernal pools for breeding. It is extirpated from most of its range in southern California, with only a few populations remaining in coastal Orange County, western Riverside County and inland San Diego County. Given that little is known of its biology and that both its terrestrial and aquatic habitats are imperiled in California, the toad is recognized as a species of special concern by the U. S. Fish and Wildlife Service and California of Department of Fish and Game, a sensitive species by the Bureau of Land Management and a species of interest by the County of Orange Natural Community Conservation Plan. In response to the need to learn more about the ecology of this cryptic species, we began a study of its movements and burrow locations using radio telemetry. To date, we have captured and surgically implanted transmitters in seven adult toads in coastal Orange County. After 70 days from initial capture, six of the toads remain within a 67 m radius of the one pool that has filled, whereas the seventh toad has moved 82 m from that pool. From field observations, the toads do not seem to show a habitat preference for burrowing sites, but the data have yet to be analyzed.

109. THE CRICKET CENSUS: SEX SPECIFIC COSTS ASSOCIATED WITH SEX-BIASED POPULATIONS IN HOUSE CRICKET ACHETA DOMESTICUS

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Lifespan and aging are traits that are dependent on environmental and social factors and are also closely related to fitness. However, how these traits are affected by social interactions is poorly understood. The social environment can result in a variety of costs that manifest differently between sexes. We manipulated social interactions by changing the sex ratio of experimental populations and examined the effects on life-history traits of house crickets *Acheta domesticus*. Specifically, we investigated early and late life mortality rates, lifespan, fecundity and quality of eggs by measurements of egg length. It was hypothesized that skewed sex-ratios will reduce the longevity of both sexes, and that the costs associated with sex-biased populations will be sex specific. Sex ratio did not impact the longevity of either sex, but it was determined that populations that had male biased sex ratios produced more eggs than populations that were female biased or had a 1:1 sex ratio.

110. THE IMPACT OF AGE AND MATE QUALITY ON RESOURCE ALLOCATION IN THE HOUSE CRICKET, *ACHETA DOMESTICUS*

Kerianne K. Murphy and Sean E. Walker. CSU Fullerton.

Reproductive allocation varies with age, mating status and mate quality. Two hypotheses try to explain how mate attractiveness affects reproductive allocation. Reproductive compensation (RC) predicts a female will allocate more resources towards reproduction when her mate is unattractive. Differential allocation (DA) predicts females will allocate more resources when her mate is attractive. We wished to determine which strategy of reproductive allocation is used by house crickets, *Acheta domesticus*, and how it varies with age. Older females lay fewer but longer eggs. Regardless of age, female house crickets mated to unattractive males have higher initial rates of egg production compared to females mated to attractive males. Hatching rates don't vary with female age or male attractiveness. However, fertilization rates were highest in young females mated with attractive males and lowest for old females mated with attractive males suggesting attractive males may vary their reproductive investment in response to female age but unattractive males do not. Clearly, house crickets do not strictly adhere to either DA or RC and both male and female strategies vary depending on the context.

111. TRACKING WILDLIFE MOVEMENT BETWEEN THE LOYOLA MARYMOUNT UNIVERSITY CAMPUS AND THE PLAYA VISTA RIPARIAN CORRIDOR USING MOTION SENSING CAMERAS

Courtney McCammon[1], Mentors: Dr. John Dorsey[2], and Dr. Eric Strauss[3]. [1]Rains Scholar, Natural Science, 2012; [2]Civil Engineering and Environmental Sciences; [3]Biology and the LMU Center for Urban Resilience.

The upland border habitats of urban wetland systems are likely critical areas that support remnant populations of both native and introduced species of mammals. Loyola Marymount University is situated in a wildlife corridor lying southwest of the Ballona Wetlands, offering resources they would not otherwise be available to resident species. The exploitation of the University's campus suggests a resilient behavior pattern of resident animals and the possibility of the campus serving as an ecological sink. The study area includes Loyola Marymount University, the adjacent bluff, and the constructed Riparian Corridor on the Playa Vista property beneath LMU.

The aim of this study was to characterize the animal movement patterns onto LMU's campus and in the surrounding bluff habitat in preparation for future radio-telemetry studies. Presence-absence data were gathered using motion-sensored cameras with infrared technology. There were four different "areas" being sampled (University Hall, the Riparian Corridor, LMU trail, and Cabora Road) with three strategically placed cameras in each area. Cameras were placed on or around game trails leading to the university's campus and onto the adjacent bluff. GPS locations were taken of animal trails and holes in the LMU fence in order to find a relationship between trails and entrance onto LMU's campus.

Results showed a range of mammals (foxes, raccoons, possums, feral cats, skunks) moving on and off campus, providing insight to LMU's relationship with the local wildlife. This study also highlights the importance of wildlife corridors within heavily urbanized areas, providing a knowledge base for future wildlife research at LMU.

112. DOES THE NUMBER AND DURATION OF VISITS AFFECT ESTIMATES OF SEED REMOVAL BY MOJAVE DESERT RODENTS?

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Behavioral ecologists are sometimes forced to use indirect approaches to understand decisions involved in foraging behavior of secretive animals, such as rodents. Many foraging experiments have measured rates of seed removal by rodents in artificial trays, but few studies have measured type of species visiting the trays, number of individuals foraging, and amount of time spent in the tray. Foraging activity of Merriam's kangaroo rat (*Dipodomys merriami*) was documented at seed trays in the Mojave Desert using Reconyx PC800 wildlife cameras to quantify how rates of seed removal were affected by amount of seed provided, number of foragers, and duration of foraging bouts. Preliminary trials indicated that *D. merriami* was able to harvest >90% of millet seeds from seed trays over the course of a night, regardless of the amount of seed provided (2–16g). Giving-up densities, the amount of seed left behind by a foraging animal, were similar across all seed amounts provided (0.04–0.2g). In several cases, both the number of visits and total time spent in trays increased with increasing seed densities. Foraging visits tended to be shortest at the lowest seed densities (2g) but rodents still returned to the depleted trays throughout the night. Continued sampling throughout the season will distinguish individual foragers at experimental resource patches through use of characteristic markings in order to gain more insight into the nature of foraging behavior of *D. merriami.*

113. EFFECTS OF URBANIZATION ON SPECIES RICHNESS AND ACTIVITY OF SOUTHERN CALIFORNIA BATS

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The rate of conversion of natural environments into urbanized landscapes is on the rise. Bats species differ in their ability to tolerate an increasing urban environment. Urbanization can result in a loss of roosting sites and foraging areas for many bat species. However, the factors that allow some species of bats to survive in urban cities and landscapes, while others perish are unclear. Southern California is home to at least 14 species of bats, but little is known about the effect of urbanization on their populations. We used a Pettersson D240× bat detector to perform acoustic monitoring of bat calls to assess how bat species richness and activity change across four sites throughout the San Gabriel Valley with different natural microhabitat and urbanization characteristics. We hypothesized that sites with high levels of urbanization and highly homogeneous microhabitats would have low levels of bat activity and low species richness. Preliminary sampling revealed high variation in bat activity levels across sites (range: 0.25–172.5 passes/hr). General characterization of echolocation calls using Sonobat revealed the presence of at least four species across the sites: *Lasiurus cinereus*, *Tadarida brasiliensis*, *Myotis californicus* and *Eptesicus fuscus.* Future sampling is required to determine how specific microhabitat and landscape level characteristics at each site affect bat activity. Sampling will continue throughout the summer to determine trends in activity levels and species richness across sites. Understanding how bats are affected by the loss and fragmentation of their natural habitat will aid in regional bat conservation efforts.

114. DEFENSES AGAINST FALL ARMYWORM IN A LANDRACE MAIZE AND ITS BALSAS TEOSINTE ANCESTOR

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Fall armyworm (*Spodoptera frugiperda*) is among the most important maize pests in Mexico. Improving maize resistance to fall armyworm has significant implications for ensuring economic and food security for millions of Mexican maize farmers. Based on prior studies, we hypothesized that defense genes against fall armyworm are present in ancestral species of maize, the Balsas teosinte. In general, maize likely developed weakened herbivore defenses over 10,000 years of agronomic selection from Balsas teosinte because plant

resources were reallocated toward yield increases and away from anti-herbivore defenses. This theory is supported by field data from the Mexican community, El Cuyotomate, where the percentage of landrace maize damaged by fall armyworm is consistently greater than the percentage of a micro-sympatric Balsas teosinte. The immediate aim of this project was to use Petri dish bioassays to evaluate whether excised tissue from this Balsas teosinte (*Zea mays ssp. parviglumis*) inhibits fall armyworm growth and feeding in comparison to the El Cuyotomate landrace maize (*Zea mays ssp. mays*). Defense chemicals in the leaves are likely factors that would inhibit growth and feeding. Other possible defense factors include the toughness and the morphology of the leaves. Additionally, we assessed whether such defenses were inducible (or not) by the feeding of larvae. Our results suggest that defense against larvae was stronger in the Balsas teosinte than in the maize; however, feeding seemed to inhibit defenses in both.

115. EFFECTS OF DIETARY RESTRICTION AND FOOD ODOR ON LIFESPAN IN *ACHETA DOMESTICUS*

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Dietary restriction is a known factor that extends lifespan in many organisms. *Drosophila* is a common model organism used to study this effect and recent studies show that just exposure to food odors or defects in olfactory senses also influence fruit fly lifespan. We want to test the hypothesis that dietary restriction extends lifespan in House Crickets (*Acheta domesticus*). In addition, we want to observe if dietary restriction coupled with the elimination of food odors will further increase lifespan as seen in studies of fruit flies. House crickets are ideal models to observe this effect due to their short life cycle and keen sense of smell. We examined the effects of food restriction and food odors on lifespan in female house crickets by varying the frequency with which we fed the crickets and the availability of food odor in the environment. There was a significant effect of our treatments on lifespan. The short-term food restriction without food odors treatment had the longest lifespan although this was not statistically different from the control. Long term food deprivation and presence of food odor seem to shorten lifespan. Our results differ from previous work in that we did not find a strong effect of dietary restriction. However, our methodology involved food deprivation to create a caloric restriction. While this didn't immediately result in changes in lifespan, it could have resulted in increased stress and shorter lifespans. In future work, we will investigate ways to reduce caloric intake without long periods of food deprivation.

116. ADDRESSING *ACINETOBACTER* INFECTION: BY FOCUSING ON HEALTHCARE PROFESSIONALS HAND HYGIENE TECHNIQUES

S. Mantravadi. California State University.

Critically ill and immunocompromised patients in intensive care units, sub acute and chronic healthcare facilities are prone to nosocomial infections. Compliance of health care professional to simple hygiene procedures such as hand washing will facilitate preserving the aseptic chain during patient treatment. This public health issue will be addressed by identifying the varied etiologic factors. Theories of behavior change will be applied to effectively educate and reinforce the need for adhering to strict hand hygiene procedures by health care providers. This will facilitate and prevent cross infection and further reduce insult to debilitated patients. These simple and cost effective procedures will decrease hospital stay and thus play a significant role in lowering our strained and burdened health care budget.

117. RELATION OF MODERNIZATION AND HEALTH RELATED KNOWELDGE TO BLOOD PRESSURE IN RURAL VILLAGES IN TAMIL NADU, INDIA

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As the lifestyle in India continues to urbanize and modernize, and patterns of living also transform it was examined if these changes could be contributing factors to the growing number of hypertensive individuals in India. In this study data was collected from 10 rural villages in Tamil Nadu, India in order

to better understand the development of hypertension in these areas. The degree to which villagers practiced positive and negative habits related to hypertension and the influence of modernization and technology in the villages were recorded. The survey administered was designed to learn about lifestyle the villagers. More specifically, the survey focused on the villagers' dietary patterns, level of physical activity, feelings/understanding of hypertension, and current level of modernization. Blood pressure measurements of the villagers were also recorded. A total of 158 individuals were interviewed. From the survey and blood pressure readings statistical tests were run in order to identify correlations between hypertensive villagers and lifestyle patterns. In areas where villagers engaged in distinctly different lifestyle behaviors, statistical differences in their blood pressures were identified, pointing to the role lifestyle choices play in development of hypertension.

118. EXPRESSION PATTERNS OF A CYTOCHROME P450 (CYP71A1) IN AVOCADO (*PERSEA AMERICANA, CV HASS*) CELL CULTURES

Rui Li and **Kristin Bozak.** California State Polytechnic University, Department of Biology, 3801 W. Temple Av. Pomona, CA 91768.

Ethylene regulates a specific set of genes that encode proteins with specific functions in plant growth and developmental processes. One of these genes has been identified as a cytochrome P450 monooxygenase enzyme, and designated Cyp71A1 in Avocados. However, the role of this protein in plant growth and development remains unknown. Our previous results showed that wounding stress induced the accumulation of Cyp71A and the production of ethylene in Avocados. In establishing a cell suspension culture of avocado to study expression patterns of P450, we found that constant shaking (shearing stress) induced the expression of P450, and released ethylene (92.0 ppm/d/g fresh cell) during culture. The induction of the gene was intensified when cells were exposed to 50 M jasmonic acid, 100 M salicylic acid, and fungal elicitor (100 g/ml of *P. cinnamomi*) for 6 hours. Application of AVG (amino-ethoxy-vinyglycine), an ethylene synthesis inhibitor, reduced the production of ethylene, but did not affect the induction of P450 at the transcriptional level. These results are consistent with the preliminary results obtained from transgenic *Arabidopsis* harboring a chimera with the reporter gene GUS under control of a 1 kb promoter from Cyp71A. Our results implicate that the effect of shearing should be considered if using a cell suspension culture as model system to study gene expression. This work was supported by an NIH-MBRS grant to KRB.

119. *IN VITRO* ASSAY INVOLVING THE MATURATION AND DIFFERENTIATION OF CD4-CD8- DOUBLE NEGATIVE THYMOCYTE SUBPOPULATIONS DEFINED BY EXPRESSION OF CD44 AND CD25 WHEN EXPOSED TO LOW DOSE CONCENTRATIONS OF DIETHYLSTILBESTROL

J. Bruley and C. Broussard, PhD. University of La Verne, Department of Biology, La Verne, CA. 91750.

The immune system is critical in protecting organisms, including humans, from infectious diseases, parasites, and cancer. A key component of the immune system is T-lymphocytes. T- lymphocytes develop in the thymus from immature precursors called thymocytes, and expression of a particular T-cell receptor dictates function. As previously shown by our group, when embryonic thymocytes are exposed to diethylstilbestrol (DES), a drug prescribed to pregnant women until the 1970s, T-cell differentiation and maturation is altered. This study aims to understand how endocrine disrupting chemicals (EDC's) like DES alter T-lymphocyte development. One potential hypothesis is that EDCs affect of the earliest stage of thymocyte development, the double negative stage. Embryonic mouse CD4-CD8- double negative thymocytes (DN) have been subdivided into four subsets based on the expression of CD44 and CD25. We wished to determine whether DES alters the four DN subsets as part of the mechanism leading to the previously observed negative effects of DES on thymocyte development. To address our question, C57BL/6 embryonic thymocytes were enriched for the DN populations using magnetic-bead separation. Enriched DN subsets were exposed *in vitro* to low dose concentrations of DES. We present data on DES effects on the maturation and differentiation of thymocytes at the earliest stage of their development.

120. ESTROGEN RECEPTOR USAGE BY ENDOCRINE DISRUPTING CHEMICALS DES AND HPTE ON EMBRYONIC TYMOCYTES

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Endocrine disrupting chemicals (EDCs) are synthetic organic compounds commonly found in the environment. Research shows that EDCs affect the endocrine system either by binding to estrogen receptors or blocking synthesis or transport of hormones. EDCs that bind to estrogen receptors can act as agonists whereas others can act as antagonists. By behaving as biological signals, EDC signals can be easily misinterpreted by an organism's cell receptors. Evidence has shown that EDCs negatively affect the reproductive fitness of adults and the developing endocrine system of embryos. Two known EDCs that have been extensively studied are diethylstilbestrol (DES) and 2,2-bis(p-hydroxyphenyl)- 1,1,1-trichloroethane (HPTE). Research shows that both DES and HPTE suppress the development of fetal immune systems with their estrogenic properties. However, little is known about the pathways that these two chemicals utilize to mediate their effects on the immune system of the body. The focus of this study is to determine which receptors DES and HPTE bind to on the surface of T-cells – whether they are the classical estrogen receptors, ER alpha and ER beta, or the nonclassical estrogen receptor, GPR 30. Our results suggest that DES might be using ER alpha to mediate its effects in T-cells whereas HPTE might be using either ER beta or GPR 30. By gaining a better understanding of how EDCs interact with T-cells, we will be able to better understand the effects of EDCs on the immune system.

121. DETERMINATION OF LOWEST-OBSERVED-ADVERSE-EFFECT-LEVEL OF BISPHENOL A ON THE DIFFERENTIATION AND VIABILITY OF EMBRYONIC C57BL/6 MICE THYMOCYTES

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The immune system plays a major role in the body's defense against disease and pathogens. However, when exposed to environmental agents, such as endocrine disrupting chemicals (EDC), the immune system can become altered and have devastating tolls on an organisms ability to fight infectious diseases and cancers. Endocrine disrupting chemicals are a specific group of environmental agents that can disrupt the normal function of the body by mimicking or blocking certain hormones within the body. A ubiquitous EDC that many people come into contact with on an everyday basis is Bisphenol A (BPA). BPA is used to create polycarbonate plastics and epoxy resins, which allows for molded structure, flexibility, and for some lightness. Despite its popularity, few studies have examined BPA's effects on the developing immune system of an embryo, specifically thymocyte differentiation and viability. An *in vitro assay* was used to determine the lowest-observed-adverse-effect-level (LOAEL) of BPA within the immune system. Embryonic thymocytes were exposed to various concentrations of BPA to determine the effects of BPA on the differentiation and viability of thymocytes.

122. HPTE INDUCED APOPTOSIS IN C57B1/6 EMBRYONIC THYMOCYTES

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Chemicals that enter the body of an organism and simulate the hormones normally present in that organism are termed Endocrine disrupting chemicals (EDC). Previous studies suggest that compounds used in industry and agriculture, such as pesticides can be introduced into the human body through food webs and drinking water. Once in the body, these compounds can modify the immune system leading to alteration and suppression of its normal function. Methoxychlor is a pesticide that was once widely used as a replacement for DDT. When Methoxychlor enters the body it is metabolized into 2,2-bis (p-hydroxyphenyl)- 1,1,1-trichloroethane (HPTE). This metabolite is known to be one hundred times more estrogenic than natural estrogen, and is thus an EDC of interest. Using an *in vitro* assay, this research attempts to detect the mechanisms via classical or non classical estrogen receptors, by which HPTE alters the normal development and differentiation of thymocytes in embryonic C57BL/6 mice. Experimental conditions consist of thymocyte extraction and EDC exposure, with timed evaluation using Annexin V

and PI staining. Our initial data suggests that HPTE may induce thymocyte apoptosis as early as four hours after exposure. This rapid response suggests that HPTE may use a non-classical estrogen receptor to induce effects in developing thymocytes.

123. THE EFFECTS OF DIETHYLSTILBESTROL ON MATURATION AND DIFFERENTIATION OF SEX SPECIFIC EMBRYONIC C57BL/6 THYMOCYTES IN ORGAN CULTURE

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The endocrine system consists of a network of hormone producing glands. Hormones are released in carefully measured doses and serve as chemical messengers that regulate many of the body's functions, including the immune system. Endocrine disrupting chemicals (EDCs) are substances, which interfere with the natural occurring endocrine system of the body. These chemicals mimic hormone like properties which can disrupt the development of the immune system. Furthermore, it has been demonstrated in studies of neonatal and adult systems that sex is also a variable in the effects of EDCs. Diethylstilbestrol (DES) was once prescribed during pregnancy to prevent miscarriages or premature deliveries and was later discovered to cause endocrine disruption and health risks, such as cancer. Various studies have shown that DES impacts developing thymocytes, yet no studies have examined how effects of DES differs based on sex of the embryo. The aim of this study is to investigate the effects of DES on the different subpopulations of developing embryonic T cells based on sex of the embryo. PCR- amplification of a gene on the Y chromosome was used in sex identification and an *ex vitro* assay was used to examine the development of T cells. Thymii were extracted from C57BL/6 mice embryos at 16 to 18 days of gestations. Our results indicate a decrease in T cell viability of both sexes in a dose dependent manner, and effects on the different subpopulations were also observed. These findings suggest that DES affects normal development and survival rate of both male and female embryonic T cells.

124. A PILOT STUDY TO INVESTIGATE THE EFFECT OF VOLUNTARY WHEEL RUNNING ON THE REGENERATION OF NERVE FIBERS AFTER A DORSAL COLUMN LESION

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Exercise, through step training or voluntary wheel running, has been shown to have positive effects on locomotor recovery and fiber regeneration after mid-thoracic spinal cord injuries. It is unknown if exercise would facilitate regeneration in a dorsal column (DC)/sciatic nerve (SN) lesion model already shown to facilitate regeneration of lesioned dorsal column fibers. To test this, mice were divided into four groups: a DC lesion, a DC lesion with wheel running, a DC and SN lesion, or a DC and SN lesion with wheel running. We hypothesized that regeneration would be increased in the running groups. Mice in the running groups did not run as expected; only 5 of 18 mice averaged more than 50 m/day. However, the preliminary results from stereological quantification of fibers with the retrograde tracer were positive. Groups that were exposed to the wheel showed increased regeneration/sprouting compared to groups that were not housed with a wheel. These observations suggest that the presence of a wheel may be an enrichment factor that stimulates the regeneration of nerve fibers after a spinal cord injury. Future studies may expose mice to wheel running prior to injury or implicate an automated wheel to increase running from the animals.

125. STRUCTURE, PERMIABILITY, AND FORMATION OF PERITROPHIC MEMBRANE IN *MEGATHURA CRENULATA*

J.E. Valk and G. Martin. Occidental College, Department of Biology, Los Angeles, CA, 90041.

A peritrophic membrane (PtM) is an acellular sheath composed of chitin that is secreted by the lining of an organism's gut. Once secreted, a PtM encases non-digestible materials and is expelled from the animal's body. These structures are most widely known in arthropods. Specifically, they have received considerable

attention as a structure that may impede the passage of microbes and larger pathogens into the gut epithelium. In this study, we began research on the PtM in the vetigastropod, *Megathura crenulata*. PtM's up to 70 mm in length and 1 mm in diameter can be collected extending from the apical hole in their shell. Research was conducted to determine its composition and permeability as well as where it is synthesized within the gut. Sections of the sheaths were each treated with different enzymes, but were only broken down in the presence of chitinase. The structure of PtM was examined using both light and electron microscopy. The PtM is clearly able to prevent bacteria from reaching the epithelial surface, but its permeability to smaller particles (viruses) requires more work. Two methods were used when examining the digestive tract to find regions secreting the PtM. These include examination of microvilli using light and scanning electron microscopy as well as treatment of PtM with fluorescently labeled wheat germ agglutinin (FITC-WGA) which binds specifically to chitin. This work extends the survey of molluscan PtM by Peters (1968).

ABSTRACTS FOR SATURDAY SESSION

126. NATURAL OFFSHORE OIL SEEPAGE IN SOUTHERN CALIFORNIA: TEN YEARS OF RESEARCH 2001–2011

Thomas D. Lorenson[1], Mary Elaine Helix[2], and Ira Leifer[3]. [1]U.S. Geological Survey, Pacific Coastal and Marine Science Center, Menlo Park, CA; [2]U.S. Bureau of Ocean Energy Management, 333 Bush St. San Francisco, CA; [3]Marine Science Institute, University of California, Santa Barbara, Santa Barbara, CA.

The USGS in partnership with BOEM, UCSB, and the county of Santa Barbara has been conducting research in the source identification and quantification of natural oil and gas seepage offshore Southern California. Oil seepage is well known at Coal Oil Point near Santa Barbara where oil droplets rise to the sea surface at estimated rates of 100 to 600 barrels per day. Lesser known, but massive occurrences of asphaltic seepage occur on the seafloor from Santa Barbara to west Point Conception. Near Point Conception coalescing asphalt mounds with concurrent gas seepage are 10 to 500 m in diameter, as much as 18 m thick, and cover an estimated 8.4 km^2 of the seafloor. The volume of asphalt is estimated to be about 27 million m^3, the equivalent of 170 million barrels of oil. The largest contiguous area covers about 2 km^2, is as much as 10 m thick, and occurs in water depths of 50 to 70 m. The age of the flows is unknown, however the areal extent of the flows coupled with the asphalt volume of currently erupting flows suggest the asphalt complex to be at least hundreds of years old. The oil composition of these seeps and tarballs deposited on the beaches of Southern California are genetically similar and in most cases can be distinguished from produced oils within a timeframe of one month or less. This ability diminishes over time as biodegradation and weathering breaks down the biomarker compounds used to identify oil residues. In the Southern Santa Maria Basin, produced oils are chemically distinct from seepage regardless of normal degradation.

127. SEAFLOOR MAPPING AND VIDEO GROUND-TRUTH OF TAR MOUNDS AND GAS SEEPS IN THE SANTA BARBARA CHANNEL, SOUTHERN CALIFORNIA

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The U.S. Geological Survey (USGS) in cooperation with Federal and State agencies, universities, and industry has collected high-resolution bathymetry and acoustic backscatter data in both the nearshore and offshore regions of the Santa Barbara Channel. The USGS also collected seafloor video and photography

by towing a camera sled over selected transects in the nearshore region. These data are being used to support benthic habitat and geologic studies for the California Seafloor Mapping Program (CSMP) and contribute to a range of coastal and marine spatial planning efforts. CSMP was established to create a comprehensive coastal/marine bathymetry, geology, and habitat base map series for all of California's State waters. The Santa Barbara Channel mapping has revealed low-relief mounds and pockmarks associated with tar mounds and natural gas seepage. Video mosaic images created from the seafloor video confirm that the mounds are composed of lobes of tar with a thin cover of sediment. Gas bubbles were also observed seeping from pockmarks. The USGS also recently completed mapping of the mainland shelf in the eastern Santa Barbara Channel, filling the gap between data collected by the Monterey Bay Aquarium Research Institute in 1998 and the USGS in 2004 and more recent CSMP mapping. The bathymetry and backscatter data reveal that most of the shelf is composed of low-relief, lower backscatter seafloor probably covered in sediment. However, towards the north, there are linear east-west trending anticlinal ridges with higher backscatter that may consist of bedrock outcrop.

128. GEOLOGIC CONTROL ON HYDROCARBON SEEPAGE ALONG THE NORTHERN COASTAL AREA OF THE SANTA BARBARA CHANNEL, CALIFORNIA

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Along the northern shelf and coastal areas of the Santa Barbara Channel are numerous areas where hydrocarbons (oil and gas) are coming to the surface. The source of the hydrocarbons is primarily the highly organic sections of the Monterey Formation. The Monterey Formation reached depths where the rock became hot enough to generate hydrocarbons only a few million years ago and is generating hydrocarbons now. During this same geologic time frame the area has undergone local extension, strike-slip, and compressional tectonics. Hydrocarbons began migrating into structures forming simultaneous to hydrocarbon generation. In the Santa Barbara Channel area the Monterey Formation is overlain by the Sisquoc Formation, a diatomaceous claystone which is impermeable and forms the seal for trapping hydrocarbons in the Monterey Formation. Where this seal is breached by erosion or faulting and fracturing, hydrocarbons can escape traps or migrate directly from the generation areas to the surface. The erosional breaches are commonly observed where the Monterey Formation outcrops along the Santa Barbara coast as tar flows, mounds, active seeps, tar filled fractures, and brecciated zones often associated with faults. Hydrocarbon seeps also occur where Monterey Formation outcrops on the sea floor and where faults and fractures have broken through the sealing rocks. The permeability of the faults and fractures depends on the state of stress across them, the amount of damage to the rocks by the fault motion, the subsurface pressure, and how much these pathways have been subsequently sealed by minerals precipitating in the open fractures.

129. BIOGEOGRAPHY OF TAR SEEPS IN THE SOUTHERN CALIFORNIA BIGHT

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Marine tar seeps tend to be oases of benthic life, with microbial chemosynthesis fueling a lush growth of infauna and epifauna. However, the microbial ecology of these features is not well understood. Using AUV *Sentry*, ROV *Jason*, and DSV *Alvin*, we have performed extensive surveys of a variety of seep sites in the Southern California Bight, ranging from massive, extinct asphalt volcanoes that still support a diverse epifauna, to shallow depressions thickly covered with microbial mats and nearly devoid of epifauna. I will discuss the biogeographical patterns that are emerging as we compare tar seeps and other cold hydrocarbon seeps in the Southern California Bight.

130. CHEMOMETRIC IDENTIFICATION OF GENETIC FAMILIES OF PRODUCED OILS, SEEPS, AND TARBALLS IN COASTAL CALIFORNIA

K.E. Peters[1] and T.D. Lorenson[2]. [1]Schlumberger Information Solutions, Mill Valley, CA 94941; [2]U.S. Geological Survey, Menlo Park, CA 94025.

Biomarkers, stable carbon isotopes, and other geochemical data are commonly used for conventional oil-oil or oil-source rock correlation to identify genetically distinct petroleum systems based on simple bivariate plots of independent variables. These data for oil samples can also be used to infer the oxicity of the depositional environment, lithology, organic matter input, and age of the source rock, even when rock samples are unavailable. However, two phenomena limit the utility of this approach: (1) secondary processes, such as biodegradation or high thermal maturity, can alter the data, and (2) large numbers of samples and measurements are difficult or impossible to interpret from tables or bivariate plots. For these reasons, genetic correlations use conservative parameters that resist secondary processes; typically ratios of adjacent sterane or terpane homologs and isotope ratios of whole oil, oil fractions, or individual compounds. Furthermore, chemometrics (multivariate statistics) facilitates accurate interpretation of large multivariate data sets, as demonstrated by this work. Based on a training set of 388 samples of crude oil, seep oil and tarballs from coastal California, a chemometric decision tree was used to classify hundreds of additional samples. The results identify three tribes of ^{13}C-rich oils inferred to originate from thermally mature equivalents of the clayey-siliceous, carbonaceous marl, and lower calcareous-siliceous members of the Monterey Formation exemplified by exposures at Naples Beach near Santa Barbara. Unlike conventional correlation, chemometric decision tree analysis identifies oil families *and* provides a statistical measure of the degree of confidence in each assignment.

131. QUANTIFYING OIL FLUX FROM GEOLOGIC SOURCES: CHALLENGES AND STRATEGIES

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One of the few seep areas where oil and gas emissions have been quantified is the Coal Oil Point seep field, and thus it plays a key role in global emission estimates; however, oil fluxes are at best approximately known. Novel approaches were used to characterize emission spatio-temporal variability including sonar (single-beam and multibeam), direct flux and capture, and atmospheric measurements. Several of these require knowing oil to gas ratios.

Sonar was used to elucidate the relationship of seepage to geologic structures (spatial controls) and for repeat surveys, temporal variability; however, atmospheric provided higher temporal density that yielded insights into both geologic structural relationships and demonstrated an effect from storms. Beach tar surveys confirmed seasonal variability suggesting predictable oil to gas ratios. Direct flux and direct capture studies were used to develop a resistance flow model for hydrocarbon migration providing insights into the relationship between oil and gas fluxes. Direct surface oil capture showed that slick weathering led to the formation of negatively buoyant emulsions. Atmospheric measurements also were demonstrated as useful for terrestrial emissions estimation for the La Brea seep area.

New developments in hyperspectral remote sensing will allow quantitative direct oil flux measurements to test a range of geologic control hypotheses and to refine emission estimates.

132. INVESTIGATION OF CHRONIC OILING FROM MARINE OIL SEEPS IN CALIFORNIA

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Each year, hundreds of oiled birds and numerous tarballs are found on beaches associated with "mystery spills," often attributed to natural seep oil. It is important for the California Department of Fish and Game Office of Spill Prevention and Response (OSPR) to be able to quickly determine whether mystery oiling events are likely anthropogenic vs. natural, and to determine the probable source of the oil. To address this need, we 1) compiled data on reports of live oiled birds from 2005–2010 to assess temporal and spatial patterns of chronic oiling, and 2) used chemical fingerprinting of oil samples to assess the probable oil source.

We found that the number of live oiled birds reported to the Oiled Wildlife Care Network (OWCN) was greatest from Santa Barbara to Los Angeles Counties (near known marine petroleum seeps) and peaked during late winter, in association with severe weather. The OSPR Petroleum Chemistry Laboratory analyzed oil samples using gas chromatography and mass spectrometry, and we developed a new computerized method to quickly compare up to 18 pairs of biomarker ratios (identified by USGS) between hundreds of samples in a USGS database and our own database. This screening tool identifies potentially matching samples based on similarity of ratios, and allows chemists to then investigate these samples in more detail to determine if they indeed match. Using these methods, we identified several different groupings of oil samples from mystery events with similar oil signatures, and identified potential source seeps for some groups.

133. SPATIO-TEMPORAL ANALYSIS OF AMS AND STANDARD RADIOCARBON DATES AT TULE CREEK VILLAGE (CA-SNI-25)

Jennie A. Allen, William E. Kendig, Richard B. Guttenberg, René L. Vellanoweth, and Sean Rafferty. California Coastal Archaeology Lab, California State University, Los Angeles, Department of Anthropology, Los Angeles, CA 91001.

Tule Creek Village (CA-SNI-25) is a large, multi component site located on the northwest plateau of San Nicolas Island. Continuous field and laboratory research has been ongoing at CA-SNI-25 for over a decade. Over 70 AMS and standard radiocarbon dates analyzed for this site revealing more than 5,000 years of occupational history. This study analyzes the spatial and temporal distribution of discrete deposits to define site function. Dated features include, dog and fox burials, pits and hearths, and other features. Few sites have such an extensive suite of radiocarbon dates available for spatio-temporal analysis. The use of radiocarbon dating at CA-SNI-25 has facilitated a more thorough understanding of the ceremonial and residential usages of this site.

134. A MULTI-METHODOLOGICAL APPROACH TO UNDERSTANDING THE SANDSTONE SAWS OF SAN NICOLAS ISLAND, CALIFORNIA

William Kendig, Kevin N. Smith, Jennie A. Allen, Chelsea A. Smith, René L. Vellanoweth, and Sebatian Wärmländer. California Coastal Archaeology Lab, California State University, Los Angeles, Department of Anthropology, Los Angeles, CA 91001.

In his unpublished field notes, Malcolm J. Rogers (1930) described a large village site containing numerous artifacts that he referred to as "stone saws". Tule Creek Village (CA-SNI-25) is a relatively intact multi-component Late Holocene site located on the northwest plateau directly above Corral Harbor on San Nicolas Island, California. Recent excavations at CA-SNI-25 yielded 126 utilized sandstone artifacts that may be the "stone saws" noted by Rogers. In this paper, we describe the production, morphology, and function of these tools and their spatial distribution across the site. Our original observations and experiments show that these tools were capable of working a variety of materials including, wood, bone, and marine shell. However, in depth research including, chemical, spatial, and statistical analyses, and replicative studies suggest that saws were likely used for the manufacture of single piece shell fishhooks.

135. LATE HOLOCENE SHELL FISHHOOK MANUFACTURE AT THE TULE CREEK VILLAGE SITE (CA-SNI-25), SAN NICOLAS ISLAND, CALIFORNIA

Kevin N. Smith[1], William E. Kendig[1], René L. Vellanoweth[1], and Sebastian Wärmländer[2]. [1]California Coastal Archaeology Laboratory, California State University, Los Angeles, Department of Anthropology, Los Angeles CA, 90032; [2]Stockholm University, Divison of Biophysics, 106 91 Stockholm, Sweden.

Our recent research successfully established a functional linkage between sandstone abraders and shell fishhook production at CA-SNI-25. The advent of shell fishhook technology in conjunction with the sewn plank canoe led to a more efficient exploitation of diverse marine niches in coastal and insular California. In this paper we analyze additional artifacts from the site to show that they were also used to manufacture

shell fishhooks. Consistent material selection, tool morphology, and use-wear patterns suggest that a standardized toolkit and manufacturing sequence was in use.

136. TRADE IN TAR: SOURCING ASPHALTUM IN SOUTHERN CALIFORNIA AND THE CHANNEL ISLANDS

Kaitlin M. Brown[1], René L. Vellanoweth[1], Nicholas Poister[1], Richard Gossett[2,3], and Hector Neff[2,3]. [1]California State University, Los Angeles; [2]The Institute of Integrated Research in Materials, Environment, and Society; [3]California State University, Long Beach.

Asphaltum played a vital role among the traditional cultures who occupied Southern California and the Channel Islands. For thousands of years asphaltum was used for a variety of symbolic, decorative, and practical purposes. Specifically, it caulked sea going canoes that transported people and materials to the Channel Islands. California has many active asphaltum seeps that native Californian's traded over an extensive area. Although it washes up on the beaches from submarine seeps throughout Southern California, ethnohistoric sources state that exclusively high-grade asphaltum from terrestrial seeps was used in the manufacture of plank-canoes. Previous researchers in the Old World and Mesoamerica have used GC-MS analysis to fingerprint archaeological asphaltum to its original source. However, asphaltum as an important trade element has been all but overlooked in Califronia. Only a single limited attempt has been made to analyze its distribution in 1979 (Gutman 1979). In this study, we use GC-MS to find the unique chemical biomarkers in asphaltum from archaeological sites on San Nicolas Island and attempt to fingerprint them to their original source. Using a database of asphaltum samples we collected from modern seeps, our preliminary results suggest that asphaltum was being traded in from the mainland. These results have allowed us to identifying the scope and significance of asphaltum trade in California and the Channel Islands and offer clues about the nature of prehistoric trade routes.

137. ANALYSIS OF MIDDLE HOLOCENE SHELL ARTIFACTS FROM CA-SNI-40, SAN NICHOLAS ISLAND, CALIFORNIA

Queeny G. Lapeña, Reilly F. Murphy, Amira F. Ainis, Kevin N. Smith, and René L. Vellanoweth

Recent excavations at a Middle Holocene dune site on the west end of San Nicolas Island revealed a variety of formal shell artifacts and modified shell. Four types of shell beads including a rare *Olivella* appliqué bead were found along with worked abalone, mussel, and turban snail in deposits dating around 4000 cal BP. Artifacts and modified shell are analyzed using weight, count, detailed measurements, and high powered microscopy. Manufacturing sequences are investigated through the use of replicative studies. This study sheds light on the development of stylistic attributes and shell ornament diversification during the Middle Holocene.

138. MIDDLE HOLOCENE OCCURANCES OF SHORT-TAILED ALBATROSS (*PHOEBASTRIA ALBATRUS*) AND NORTHERN FULMAR (*FULMARUS GLACIALIS*) ON SAN NICOLAS ISLAND, CA

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Short-tailed albatross and Northern fulmar have been recorded in several Middle Holocene sites on the Channel Islands. Some of these sites, such as Eel Point (CA-SCLI-43) and Thousand Springs (CA-SNI-11) yielded high MNI (minimum number of individuals) and NISP (number of individual specimens) of Short-tailed albatross. While Northern fulmar is an occasional visitor to the Channel Islands during its wintering season, Short-tailed albatross is rarely encountered. In this paper, three Middle Holocene dune sites will be discussed (CA-SNI-40, CA-SNI-41, CA-SNI-157). These sites all have high MNI and NISP of Northern fulmar with Short-tailed albatross occurring in several levels. CA-SNI-40 yielded the largest MNI of Short-tailed albatross occurring in a single stratum. Some researchers have suggested that a breeding colony occurred on San Nicolas Island during the Middle Holocene, however, our preliminary evidence questions this hypothesis. Where did these birds come from and what made them come in such large numbers to San Nicolas Island during the Middle Holocene?

139. PATHOLOGY AND TRAUMA OF RECENTLY EXCAVATED DOG BURIALS FROM SAN NICOLAS ISLAND CALIFORNIA

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As of today more complete dog burials have been found on San Nicolas Island than on any of the other seven Channel Islands. Despite the prevalence of so many deliberate dog burials on San Nicolas, little is known about how they lived and died. During the course of the 2007 and 2009 summer field seasons three complete dog burials were recovered from East Locus at CA-SNI-25. A complete osteological analysis was conducted for each dog, specifically focusing on skeletal pathology and trauma. All three of the dogs exhibit extensive osteoarthritis throughout the skeleton and severe tooth attrition, as well as multiple healed traumatic injuries. All of the dogs also exhibit very robust musculoskeletal stress markers; this combined with the nature of the pathology and trauma of these dogs suggests that they may have been working animals.

140. USING ^{13}C AND ^{15}N ISOTOPIC VALUES TO INVESTIGATE THE SIMILARITY BETWEEN THE DIETS OF ANCIENT HUMANS, DOGS AND FOXES ON SAN NICOLAS ISLAND, CALIFORNIA

Chelsea M. Smith[1], **Jessica F. Colston**[1], **René L. Vellanoweth**[1], and Matt Kowal[2]. [1]California Coastal Archaeology Laboratory, California State University, Los Angeles, Department of Anthropology, Los Angeles CA 90032; [2]University of California, Los Angeles, Department of Chemistry, Los Angeles 90095.

Stable isotope analysis serves as a useful tool to understand the ecological connections between different species found in archaeological sites. In this paper we use carbon and nitrogen isotopic delta values to reconstruct the diet of dogs (*Canis familiaris*) and foxes (*Urocyon littorlais*) found in archaeological contexts on San Nicolas Island. Our preliminary results suggest that differences in the relative contribution of terrestrial vs. marine resources to the overall diet of these species could be a result of human interaction.

141. INVESTIGATING THE POSSIBILITY OF DOMESTICATION OF ISLAND FOXES ON SAN NICOLAS ISLAND

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The arrival of the Island Fox (Urocyon littoralis) on the southern Channel Islands is generally agreed to be the result of human intervention over 5,000 years ago. Excavations on San Nicolas Island (SNI) have yielded both dog and fox burials. In certain ways the history of the Island Fox parallels that of the dog (Canis familiaris) especially on the Channel Islands. Utilizing an archaeological population of 25 individuals from multiple sites on SNI, we ask the question, did the human-fox relationship result in evidence of domestication detectable in facial morphometrics?

142. EXAMINING REGIONAL AND POPULATION LEVEL STRUCTURE IN SANTA ANA SPECKLED DACE (*RHINICHTHYS OSCULUS*) USING NUCLEAR INTRON AND MICROSATELLITE LOCI TO FURTHER ELUCIDATE MTDNA PATTERNS OF VARIATION

Stacey A. Nerkowski, Liane R. Greaver, Pia VanMeter, Jay VanMeter, and Anthony E. Metcalf. CSU San Bernardino, Department of Biology, San Bernardino, CA, 92407.

Since 2003 we have evaluated mitochondrial DNA variation in the Santa Ana Speckled Dace (SASD: *Rhinichthys osculus*) across their extant range within the Santa Ana and San Gabriel watersheds, and compared these patterns to speckled dace populations from the Central Coast and Owens Valley, CA. We

found that SASD are reciprocally monophyletic at two loci, cytochrome b and d-loop. Additionally, within SASD we have found evidence of population structure and differences in variation among drainages. To further test the evolutionary independence of SASD we are examining nuclear intron variation using exon-primed intron crossing (EPIC) primers at ten loci. Population structure is being evaluated by microsatellite analysis. In collaboration with the Savannah River Ecology Lab, 23 polymorphic microsatellite loci have been isolated from SASD and are currently being tested. Here we report on the utility of the microsatellite and EPIC loci.

143. EFFECTS OF DIETARY PHYTOESTROGENS ON PATERNAL RESPONSIVENESS AND MATURATION IN THE BIPARENTAL CALIFORNIA MOUSE

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The California mouse (*Peromyscus californicus*) is a monogamous, biparental rodent in which fathers show strong attraction to pups while virgin males show variable paternal responsiveness. Previous studies have demonstrated that circulating testosterone enhances paternal behavior in this species via aromatization to estrogen. We tested the hypothesis that paternal responsiveness in virgin males would likewise be enhanced by dietary estrogens (i.e., phytoestrogens, PE) from soy. Virgin males (N=16 per group) were fed commercially available diets containing high, intermediate, or low levels of PE, from the time of weaning until sacrifice in early adulthood, and behavioral responses to an unfamiliar pup, body mass, testis masses, fat-pad masses, and epididymal sperm counts were compared among the three groups. No differences were found in males' behavioral responses to a pup. Similarly, testis masses, fat-pad masses, and sperm counts did not differ as a function of dietary PE content. However, patterns of body mass over time differed significantly among groups ($P<0.001$), as mice on the high-PE diet gained more mass across the study than those on a low-PE diet ($P<0.001$); neither of these groups differed significantly from the intermediate-PE group. These results suggest that the levels of phytoestrogens in the three diets used in this study differentially affect patterns of physical growth but not paternal behavior, fat deposition, testicular development, or spermatogenesis.

144. THE SIGNIFICANCE OF CALCIUM CARBONATE DEPOSITS IN THE LEAVES OF *RUELLIA TUBEROSA*; DO THESE STRUCUTURES STORE THE HEAVY METAL CADMIUM?

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Cystoliths are calcium carbonate deposits found in the leaves of some flowering plant families, which form in the cell walls of lithocyst cells. The physiological significance of these structures have been dubious, with some studies suggesting a role in calcium regulation. Calcium oxalate and carbonate idioblasts, in the leaves of tobacco plants have been shown to sequester the metal cadmium and then excrete various metal containing salts through trichomes as a means of detoxification. Given the overlap in potential calcium regulation function between calcium idioblasts and cystoliths in leaves, other untested similarities may exist, such as the ability of cystoliths to also store metals. In this study, plants were grown from seed in tissue culture then transferred to either contaminated or non-contaminated growth media. By using a simple fractionation technique to separate cystoliths from the rest of leaf materials in *Ruellia tuberosa* (Acanthaceae), a chemical comparison was made (using ICP-MS) to determine if cystoliths contain the toxic heavy metal cadmium. Cystolith size and density will also be reported to ascertain if the addition of calcium or cadmium to the plant's nutrient media affect their growth and distribution. Photosynthetic florescence, root and shoot lengths and relative water content of leaves will be compared between treatment and control groups as a proxy to plant health. Another species, *Crossandra infundibuliformis*, which does not produce cystoliths, will also be measured as a comparison. Potentially, this study could elucidate new species that could be used for the phytoremediation of heavy metal contaminated soils.

145. SHIFTS IN DIETS EXHITIBITED BY COYOTES LIVING IN THE WILDLAND-URBAN INTERFACE

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Coyotes (*Canis latrans*) have successfully penetrated urban landscapes throughout the United States, including large metropolitan areas such as Los Angeles. They are also well-known predators of domestic cats and small dogs. Coyotes living on the Palos Verdes Peninsula in Los Angeles County have access to both native and non-native prey found in local preserves as well as the urbanized areas. Coyote scat content analyses were conducted within the 155-acre Forrestal Reserve of the Palos Verdes Nature Preserve. Most of the Forrestal Reserve contains prime coastal sage habitat and is used by resident coyotes for foraging and raising their young. It is bounded on three sides by single family homes possessing ample yards that are dominated by non-native flora and fauna. Through scat content investigations, we found that Palos Verdes coyotes prey regularly on domestic cat. The percentage of rodents in their diet was at a lower rate than found in the coyotes living in the Santa Monica Mountains, suggesting that their opportunistic take of domestic cats represents a shift from their natural diet.

146. BULLDOZING TO CREATE HABITAT FOR THE ENDANGERED PALOS VERDES BLUE BUTTERFLY

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The Palos Verdes blue butterfly (*Glaucopsyche lygdamus palosverdesensis)*, is found only in limited sites on the Palos Verdes Peninsula located in Southern California. A major factor responsible for the endangered status of this butterfly is a decline in suitable habitat. *Lotus scoparius* and *Astragalus trichopodus* are the butterfly's primary host plants. Both *Lotus* and *Astragulus* are pioneer species that occur in disturbed parts of Coastal Sage Scrub (CSS). Previous restoration efforts have focused on restoring CSS but without disturbed areas. In 2011, within the Defense Fuel Supply Point a bulldozer was used to mechanically remove soil to create disturbance for simulating growth of the butterfly's host plants. By removing the upper 15–30 cm of soil, a reduction in the seed bank of non-invasives would be gained while providing disturbance to promote the growth of *Lotus* and *Astragalus*. There were four treatments: disturbance only, disturbance plus seeding with *Lotus*, disturbance plus seeding with *Lotus* and *Astragalus,* and a control with no disturbance or treatment. Measurements of recruits and distances of recruits from mature plants are taken monthly. Results thus far have shown the disturbance only treatment and the disturbance plus *Lotus* seeding treatment to have the highest counts of recruits. The control site has shown the least amount of recruits. Non-natives are still prevalent within the disturbed area.

We also compared boundary conjunction, measured as Morisita's index (MI) for these sets of guilds to the weighted average of the MI values of the guilds composing them. This revealed a striking pattern in which only sets of directly interacting guilds had higher-than-baseline boundary conjunction values, and such boundary conjunction values are found in all but one set of directly interacting guilds. Our results highlight the importance of inter-guild interactions in structuring patterns of cooccurrence.

147. A GRADIENT ANALYSIS OF MULTIPLE INTERACTING GUILDS HIGHLIGHTS THE ROLE OF BIOTIC INTERACTIONS IN STRUCTURING COMMUNITIES

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The extent to which ecological communities are coherent entities as opposed to mere intersections of individual species distributions has long been one of the fundamental questions of ecology. Gradient analysis is a commonly used tool for addressing this question; however, all such studies have used

organisms from a single taxon or guild. This risks missing important connections due to non-competitive interactions, which should be more likely to occur between members of different guilds.

We examined the abundances of taxa in four interacting guilds along an elevation gradient in a southern Appalachian forest. Elements of metacommunity structure analysis was used to study the extent to which communities are made up of non-independently distributed species and tested the hypothesis that combinations of two or more interacting guilds exhibit more coherence than single guilds.

The basidiomycete subcommunity was classified as Clementsian, plants and mesostigmatids were quasi-Clementsian, and collembola were random, lacking either continuous species distributions or a systematic checkerboard pattern. When sets of multiple guilds were examined, Clementsian and quasi-Clementsian structures predominated.

148. THE RELATIONSHIP BETWEEN CONDITION, MORPH, AND STRIDULATION IN MALE PACIFIC FIELD CRICKETS (*TELEOGRYLLUS OCEANICUS*)

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Stridulation is an energetically expensive behavior used in cricket mate attraction. A mutation, *flatwing*, which renders males silent, has recently arisen in Hawaiian populations of Pacific field crickets in response to an acoustically-orienting parasitoid fly, *Ormia ochracea*. Flatwing males have been observed stridulating, but there appears to be no benefit gained from silent stridulation. If stridulation incurs only costs for flatwing males, then we would expect selection against stridulation in flatwing males. Further, the condition of an individual determines the amount of available energy the individual has to allocate to performing behaviors. Males in poor condition have less available energy to invest in expensive tasks such as stridulation, and should therefore stridulate less than males in better condition. We measured the effect of condition and morph on time spent stridulating in male Pacific field crickets. Progress towards understanding the relationship between condition, morph, and stridulation will be discussed.

149. DIFFERENCES IN GROWTH AND BIOMASS ALLOCATION PATTERNS BETWEEN NATIVE AND INTRODUCED POPULATIONS OF THE INVASIVE GRASS *BROMUS RUBENS*

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The Evolution of Increased Competitive Ability (EICA) hypothesis proposes that upon release from coevolved enemies introduced species will shift resources from defense to increased growth. If selection for such a trade-off has occurred in introduced ranges, then these genotypes should outperform native genotypes in growth rate and allocation patterns. To test this prediction of EICA, we compared the rate of carbon acquisition (photosynthetic performance) and biomass allocation patterns of *Bromus rubens* (red brome) populations from Spain (native range) and California (introduced range) grown under common conditions. Introduced populations were significantly larger than those of the native range. The total biomass and shoot height of the Californian populations were 61% and 30%, respectively, larger than the Spanish populations (total biomass: $F = 68.21$, $P < 0.0001$, shoot height: $F = 39.28$, $P < 0.0001$). However, Spanish populations showed 38% greater photosynthetic performance ($F = 17.19$, $P < 0.001$), and 15% greater root:shoot biomass ratios ($F = 8.97$, $P < 0.01$). This divergence in allocation patterns may reflect adaptations to the introduced range. For example, carbon sequestration in roots may be unnecessary in the absence of enemies, whereas greater photosynthetic performance and storage may be traits vital to survival in their presence. These results suggest that introduced genotypes of *B. rubens* experience selective pressures in novel environments that could contribute to differences in habitat distribution, abundance, and invasiveness.

150. GAS CHROMATOGRAPHY METHOD FOR ANALYZING METHYL MERCURY CONCENTRATIONS IN FISH FROM THE SANTA FE DAM RECREATION AREA LAKE

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The Council for Watershed Health's 2009 annual report of the San Gabriel River Regional Monitoring Program indicated elevated levels of mercury in some species of fish collected from the Santa Fe Dam Recreation Area Lake in Irwindale, CA, posing a potential public health risk to individuals consuming these fish. The USEPA method 245.7 of total mercury by cold vapor atomic fluorescence spectrometry was used for this analysis. The Council for Watershed Health had previously assumed nearly all mercury found was in the more toxic methyl mercury form. The agency is once again evaluating the mercury contamination in this location with an additional study into finding what percentage of the total mercury measured is methyl mercury. As a result, there was a need for development of a gas chromatography/mass spectrometry method for analyzing organic mercury compounds extracted from fish tissue, which included a pretreatment method of tissue digestion followed by organic solvent extraction and then derivatization to volatilize the compounds for GC/MS detection. The subsequent method was reasonably efficient and with further refinement would provide an alternative that is both cost effective and a more accurate analysis of environmental mercury impacts.

151. CHARACTERIZATION OF BACTERIAL SYMBIONT DIVERSITY AND FUNCTION IN DEEP SEA *OSEDAX* POLYCHAETE SPECIES

Jane Klann. Occidental College.

Marine worms of the genus *Osedax* depend on bacterial symbionts (within the Oceanospirillales) to obtain nutrients. *Osedax* hosts acquire their symbionts from the environment and can be infected by multiple symbiont strains over time. The purpose of our study was to determine the exact symbiont composition of *O. rubiplumus* and *O. frankpressi* individuals from differing collection sites to work toward the better understanding of the role of the bacterial genome in the initiation of symbiotic connection. We hypothesized that all worms would possess a dominant symbiont type (I, II, or III), but that other types could be present in lower abundance, and that non-symbiotic bacteria would be <5% of the population. Forty-eight worms, collected from 2 sites over the course of 8 years, were screened for the presence of symbiont 16S rRNA genes by DNA extraction and polymerase chain reaction (PCR) using symbiont-specific primers (435F/1213R). PCR amplification, followed by selective restriction digest, and DNA sequencing, allowed for symbiont identification. Further, to determine whether non-dominant symbiont or non-symbiotic bacteria were associated with the worms, a select number of hosts were examined for overall bacterial diversity, using clone libraries created from PCR products using a general 16S rRNA primer set (27F/1492R). Both *Osedax* host species are infected by all three known symbiont strains (I, II, and III), although symbiont type II appeared to be the most common. There was no clear pattern of symbiont colonization, with the exception of a possible temporal transition from symbiont II to symbionts I and III. Consistent with our hypothesis, a dominant symbiont was present, with other symbiont strains and environmental bacteria present in smaller proportions in the community. Overall, differing symbiont strains live in close connection with neighboring worms and better documentation of this diversity aids in the analysis of functional genes that play a role in the initiation of the symbiotic association. The chemotaxis pathway, specifically the *cheA* gene, is a target for examination in the establishment of the *Osedax*- microbe connection. A partial genome of symbiont type II is being utilized to characterize the possibility of novel metabolic capabilities of the symbiotic microbe and the nutrients it may provide to host worms.

152. TEMPORAL AND SPATIAL VARIATION IN ASCIDIAN SETTLEMENT WITHIN FOULING COMMUNITIES IN MISSION BAY, SAN DIEGO, CALIFORNIA

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Ascidians are ecologically important members of fouling communities, and often dominate on Southern California docks. While previous studies have documented the presence of native and non-indigenous ascidians in the region, generally little is known about their spatial and temporal settlement patterns, and how such variability influences population dynamics and overall fouling community development. The purpose of this study was to examine weekly ascidian settlement on replicate PVC plates deployed at five locations in Mission Bay, an urbanized estuary in San Diego, CA. Sampling locations were selected to

represent the range of environmental conditions in Mission Bay. Settlement was related to weekly measures of sea surface temperature, salinity, turbidity, and flow. While this study is ongoing, our preliminary results suggest that settlement rates may be highest at sites that receive greatest tidal flushing. Additionally, ascidian die-offs have occurred within one week of increased freshwater exposure following rain events. This study will provide valuable insight about population dynamics in coastal environments, and will serve as a valuable comparison to studies documenting ascidian settlement in other California regions.

153. CLIMATE CHANGE TRANSITION AND MARINE ECOLOGICAL CHANGES IN SAN DIEGO BAY

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Climate change transition is a current process underway in San Diego Bay and there are changes in the marine ecology of San Diego Bay. Over the last thirty years records of marine fauna from the Panamic Province have been periodically recorded in San Diego Bay. These warm water species from south of San Diego have migrated into San Diego Bay with warm water events of El Nino Southern Oscillation (ENSO). The scalloped hammerhead shark *Sphyrna lewini* has used San Diego Bay as a pup nursery. Four warm water fish species of the family Carangidae have been found in San Diego Bay. At least eight other species of warm water fish have been found in San Diego Bay. Epipelagic invertebrates associated with warm water events have migrated into north San Diego Bay with the incoming tides. Currently the benthic target shrimp *Sicyonia penicillata*, which has migrated north into the San Diego coastal environment, has been collected in 2012 benthic trawls of north San Diego Bay. This crustacean species may become a permanent addition to the San Diego Bay benthic ecosystem.

154. FOOD AND HEAT STRESS IN THE CALIFORNIA MUSSEL: EVIDENCE FOR AN ENERGETIC TRADE-OFF BETWEEN GROWTH AND SURVIVAL

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Many rocky shore organisms produce proteins (including so-called heat-shock proteins, HSPs) that help to minimize and repair cell damage in response to environmental extremes. This inducible response is assumed to be energetically expensive, suggesting that increased protein expression levels may impose a trade-off between individual growth and survival. We tested this hypothesis experimentally with the California mussel, *Mytilus californianus*. Individuals were marked and monitored along a gradient of wave exposure in the field. We observed that growth decreased with increasing average daily maximum temperature. Similarly, mussels in the lab exposed to low food ration and chronic heat stress during simulated low tides had significantly less tissue mass than control mussels after eight weeks. Nevertheless, when subsequently challenged with more extreme thermal events, mussels experiencing chronic heat stress survived best, regardless of food level. Our data are consistent with the idea that tolerating sub-lethal thermal stress is energetically costly, but that acclimation to stress increases one's tolerance to subsequent events, presumably due to elevated levels of various stress proteins. We are currently using proteomic analyses of the expression levels of HSPs and other proteins to improve our understanding of the mechanistic links between food availability, thermal stress tolerance, and demography in this key intertidal species.

155. MODELING THE DYNAMICS OF DISTURBANCE IN MUSSEL BEDS

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Realistic disturbance models could aid in management of dynamic ecological systems. Cellular automata (CA) models have been used to study disturbance dynamics in marine mussel beds, *Mytilus californianus*, usually considering transitions among small number of states and assuming a homogenous spatial environment without boundaries. More complex CA models have also been used to study mussel

bed boundary formation, considering mussel settlement and growth and predator-prey dynamics within gradients of tidal height and wave exposure. I formulate and analyze a model that combines these approaches with effects of mussel growth, size-dependent predation, and environmental gradients on disturbance dynamics. Small "patches" of the mussel bed are modeled using mean field ordinary differential equations (ODE) approximation to the complex CA model. Each patch represents an area of constant tidal height and wave exposure. Adjacent patches are linked through local interactions to form a "quilt" that spans gradients of tidal height and wave exposure. Patches are vulnerable to random disturbances that can propagate to neighboring patches, forming gaps in mussel cover. Probabilities of disturbance and propagation increase as functions of mussel biomass. Frequencies of disturbance and size distribution of gaps varied with tidal height, wave exposure, and predation intensity. Recovering gaps from previous disturbances influence the dynamics of gap formation. Highest frequency and largest size of disturbances occurred in interior areas of highest biomass. The hybrid deterministic-stochastic quilt model provides a novel paradigm for studying ecological disturbances. Realistic models of disturbance dynamics can facilitate our study of ecological processes and aid in ecosystem management.

156. EXPRESSION OF *PSF* AND *SRP20* IN THE DEVELOPING MOUSE CORTEX AND HIPPOCAMPUS

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The cortex and hippocampus are important for the control of cognitive and social behaviors, many of which are sexually dimorphic. However, the mechanisms that mediate the development of the brain structures and neural circuits underlying these functional differences between the sexes have not been discovered. Using gene expression microarrays, we have identified several novel sexually dimorphic genes expressed in the neonatal cortex and hippocampus, including polypyrimidine tract-binding protein-associated splicing factor (*Psf*) and splicing factor arginine/serine-rich 3 (*Srp20*). To validate our microarray data and further characterize their expression during early development, we used reverse transcription with real-time polychain reaction (RT-qPCR) to measure mRNA levels of *Psf* and *Srp20* genes in the mouse cortex and hippocampus collected on the day of birth (PN0). We have found that *Psf and Srp20* mRNA levels in the developing mouse cortex and hippocampus showed no sex difference in expression at birth. Our current studies are continuing to examine the mRNA expression of the two genes throughout early development to investigate whether the sexually dimorphic expression of both genes arise during early development and overlap with the critical period of sexual differentiation. If so, our results would suggest that alternative splicing may play a role in brain sexual differentiation, which involve the control of cognitive behaviors and sex-biased diseases, especially those served by the cortex and hippocampus.

157. ESTIMATION OF MUTATION RATES IN OUTCROSSING WORMS. WHOLE GENOME RE-SEQUENCING OF *CAENORHABDITIS REMANEI* MUTATION ACCUMULATION LINES

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To what degree natural selection has shaped the rate of spontaneous mutations among different taxa remains an important unresolved question in evolutionary biology. While mutation rates are known to vary among and within taxa, the relative importance of natural selection versus non-adaptive processes has yet to be determined. Classical theory predicts that the strength of natural selection to reduce the deleterious mutation rate should be stronger in asexual and selfing taxa than in outcrossing sexual taxa, leading to an adaptive decrease in mutation rate in the former. Whether this general trend exists in nature is currently unknown.

Nematodes in the genus *Caenorhabditis* provide an ideal system to test questions of how mutation rates vary among closely related species with different reproductive strategies. Within the genus the ancestral

reproductive state is outcrossing (gonochorism), however self-fertilization (hermaphroditism) has evolved independently several times. Therefore, to examine the role of mating system on the evolution of mutation rates we constructed a set of long-term mutation accumulation (MA) lines of the outcrossing species *Caenorhabditis remanei*. MA lines were maintained by transferring a single male-female pair of worms per generation. After 122 generations of MA, five randomly selected MA lines along with the ancestral control were re-sequenced using Illumina sequencing technology. We will present estimates of the rate and spectrum of molecular mutations in *C. remanei* and place these results into the broader context of previous estimates from MA lines of selfing taxa.

158. THE EFFECTS OF HEALTH AND LONGEVITY ON THE REPRODUCTIVE SUCCESS OF MALE POLYCHAETOUS ANNELID WORMS *NEANTHES ARENACEODENTATA*.

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Neanthes arenaceodentata are a unique species of polychaeteous annelid worm, in that the males care for the fertilized clutch of eggs after they are laid, as females die shortly after laying. While conducting a separate experiment analyzing a physiological aspect of the lifespan of male *Neanthes arenaceodentata*, two distinct patterns of general male health became apparent. Over the course of their mature stage, which spans up to nine reproductive events, some males were observed to have a stable pattern of health after each event. These males maintained consistently small, separate eyes, adequate gut contents, regular movements and reactivity, and no growths or lesions. Others appeared to decline steadily in apparent health, with eye deformations, little or no gut content, sluggish reactivity and disorientation, and growths inside and outside the body. Considering these patterns, we hypothesized that males with stable health will produce a significantly higher mean clutch size than those with declining health due to increased fitness and comparable longevity. Reproductive success was defined as a female worm laying a clutch of eggs, which the male guards until juveniles have twenty-one segments. The clutches of eggs in this experiment yielded cohorts that fell into five different discrete size categories: between 0–50, 50–100, 100–150, 150–200, and over 200 worms. Other factors contributing to reproductive success are whether clutches are scattered or eaten, which surprisingly occurs more often in males with a constant level of health ($n=37$) than in the declining males ($n=37$). Future data collected in this ongoing experiment are expected to support our hypothesis.

159. WAS THERE EVER A HYDROCARBON OR WATER OCEAN ON THE SATURN MOON TITAN?

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The Titan/Saturn System Mission will deploy a rover on the surface of Titan to look for microbes and to determine the chemistry of hydrocarbon lakes among other experiments. A second proposed mission to Titan called the Titan Mare Explorer or TiME would place a floating lander on the surface of one of the hydrocarbon lakes. One important question to consider in the exploration of the surface of Titan is that of a possible hydrocarbon ocean in Titan's history. Radar images of the Saturn moon Titan from the Cassini mission show evidence of hydrocarbon lakes, primarily of methane and ethane, in the northern and southern polar regions. The largest concentration of hydrocarbon lakes is in the northern polar region with the largest hydrocarbon lake defined by SAR imagery being Ligeia Mare which is the size of Lake Superior. Kraken Mare, which is a possible hydrocarbon sea on Titan, is undefined by SAR imagery. Runoff channels are evidence of hydrocarbon precipitation on Titan. Hydrocarbon precipitation on Titan has been concentrated in the polar regions in the moon's recent history. There is also currently a significantly lower level of hydrocarbon precipitation in the equatorial region of Titan. While there are hydrocarbon lakes present on Titan there is no evidence that one large hydrocarbon ocean ever existed on Titan's surface. A source for surface water on Titan would be cryovolcanism.There is no conclusive evidence that cryovolcanism has ever taken place on Titan. If the internal ocean of Titan is considered a source for cryovolcanism, the thick crust of Titan may prevent internal ocean water from reaching the surface. Titan has a decoupled crust of 200 km over a 400 km layer of internal ocean. There is no evidence that there was ever a water ocean on Titan.

160. ASSESSING *POLIOPTILA CALIFORNICA* POPULATION IN DIFFERING *ARTEMISIA CALIFORNICA* HABITATS

Christine Chen. Palos Verdes High School, Palos Verdes Peninsula Land Conservancy.

This purpose of this project is to study the California gnatcatcher (Polioptila *californica*)bird population in a newly restored California sagebrush(*Artemisia californica*)habitat versus that of a mature habitat. I hypothesize that with an increase of plant growth at the newly restored habitat, the California gnatcatcher population at the newly restored site will also increase. I conducted bird surveys in which I counted the number of birds at the two different reserves-the mature habitat, Vicente Bluffs reserve and the newly restored habitat, Three Sisters reserve. The surveys at each reserve were conducted at two stations in the morning, and exactly 10 minutes long, where all visible and audible California gnatcatchers within a 75 meter radius were counted and recorded. I also collected measurements of the California sagebrush within 6 month intervals at both sites to assess the growth of each habitat. The observations noted in my research and the statistical analysis using an ANOVA test, Multiple Comparison Charts and Mann Whitney Rank Sum Test demonstrate that the growth at the newly restored site has a correlation to an increase of abundance of the California gnatcatcher at the newly restored site. These results are significant as they demonstrate the gnatcatcher utilizing the newly restored habitat after two years, much earlier than what is expected. And observations such as two gnatcatchers teaching their juvenile gnatcatchers how to forge gives me the confidence to predict that as this land reserve continues to mature, the California gnatcatcher population will eventually match that of the mature habitat.

161. THE SURVIVAL OF *HIPPOLYTE CLARKI* IN VARIOUS PHYSICAL HABITATS

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Grass Shrimp (*Hippolyte clarki*) have been known to dwell in low intertidal habitats, such as eelgrass beds or kelp forests. This experiment sets out to determine which physical habitat is most suitable for the shrimp. The initial idea was to observe how various habitats influence the longevity of grass shrimp.

The specimens were place in pseudokreisel tanks that contained a bag of mud with eelgrass, kelp, or artificial eelgrass protruding out of each bag. The control had a bag of mud with holes, similarly to the eelgrass, kelp, and artificial eelgrass. However, the bag did not have any substrate protruding out of it. This tank set-up allowed for animal interaction with the substrate in the tanks. In all of the trials, the number of shrimp in each tank were counted and recorded.

The data collected showed that the number of shrimp in the Macrocystis pyrifera, artificial eelgrass and control were fairly constant. Statistical test show that the abundance of shrimp in the Macrocystis pyrifera and the artificial were significantly different compared to the control group. The shrimp in the two substrates were distributed farther way from the other shrimp within the same tank because the substrates in the tanks allowed for more surface area for attachment and more concealed areas, both of which would decrease the amount of cannibalism that occurred.

162. ENVIRONMENTAL AND COMMERCIAL BENEFITS OF CARBON SEQUESTRATION BY *ENCELIA CALIFORNICA* AND *SALVIA LEUCOPHYLLA*

Rachel Dokko. Palos Verdes Peninsula H.S. and U.C.L.A (Dr. Shafari lab.).

Because global climate change is a widespread concern, studies that reduce the emissions of CO_2 and other greenhouse gases through plant carbon sequestration are of great interest. Plants are major reservoirs of atmospheric carbon and CO_2 levels fluctuate with their photosynthetic patterns. Carbon sequestration refers to the storage of CO_2 into reservoirs, and describes a method to delay global warming effects and slow the accumulation of greenhouse gases. Specifically, this study quantifies the biomass dry weight of two common drought-deciduous species, *Salvia leucophylla* and *Encelia californica*. These species are part of an ongoing coastal sage scrub CO_2 sequestration study also involving *Eriogonum cinereum* and *Rhus integrifolia*.

Two methods were used to collect *S. leucophylla* and *E. californica* samples. In Method 1, 12.5–50% of the subject was harvested and dried, and canopy measurements were recorded. Method 2 also required

field measurements in addition to five branch samplings from each. This was the sub-sample later used to calculate the biomass. (*Encelia californica* was collected using only method 1.)

Using regression analysis, the results showed that *S. leucophylla* showed a strong correlation in its biomass and canopy dimension relationships. The correlation between the biomass and the surface area was $y = 185.37x^{1.4514}$ and the correlation between the biomass and volume was $y = 117.92x^2 + 420.93x + 659.72$. *Encelia californica* also displayed strong correlations. The correlation between biomass and surface area was $y = 149.86e^{1.5926x}$ and the correlation between biomass and volume was $y = 121e^{0.4317x}$.

This information will calculate the amount of CO_2 sequestered using only canopy measurements while also planting in specific areas to maintain the natural balance of carbon between Earth and the atmosphere.

163. ATTEMPTS TO INCREASE ROBUSTNESS OF WHITE SEABASS *ATRACTOSCION NOBILIS* IN A FULLY CLOSED RECIRCULATING SYSTEM

Sam Holley and **John Su**. Huntington Beach High School.

Since the decline of the white seabass Atractoscion nobilis in the 1930's, efforts have been made to replenish the native population of this ecologically and commercially important fish by growing them in open and semi-closed seawater systems. In the fall of 2010, a study at Huntington Beach High School in Huntington Beach, California was conducted and determined that white seabass could survive in a fully closed recirculating system when given the necessary parameters. Similarly in the fall of 2011, populations of white seabass *Atractoscion nobilis* from the Hubbs Seaworld Research Institute (HSWRI) in Carlsbad, California were studied in Huntington Beach High School's facilities. The objective of this second study aimed to increase the robustness of the fish before releasing them back into the ocean. Forty juvenile white seabass were held for 90 days in a 1,400 L circular, polyethylene plastic pool containing artificially mixed saltwater. In addition, another biological filter consisting of bio-balls was added onto the system to offset the high nitrate and nitrite levels recorded last year. Water flow, water chemistry, system design, light conditions, seawater composition, fish behavior, feeding rate, growth rate, stocking density, and animal stresses were documented variables and compared to data collected last year. Throughout the study, the main discrepancies involved fluctuating levels of ammonia and improved eating behavior by the fish. At the end of the 90 day trial, 93% of 40 fish survived and results indicated improved robustness of the fish.

164. THE EFFECTS OF MAN-MADE STRUCTURES ON WIND PATTERNS

Wei Jing and **Steven Tan**. Gabrielino High School; Mentor: Matthew Escarra.

The rising number of cities creates urban heat islands which cause uneven distribution of heat between urban and rural areas. One method in which heat is directed away from cities is through wind. Two types of experiments were conducted regarding wind patterns. Data was collected from 11 different locations at the Gabrielino High School campus and was compared with model results. The data showed that urban structures create localized areas with higher wind velocity. The taller the building, the stronger the updraft of wind was over the structure. A difference of 3 meters in height between areas A & C and the area B induced an average increase of 1.5 km/hr in wind speed of the higher area. High heat absorption areas surrounded by denser air reflects surges in velocity. The temperature of the football field causes the wind to increase in velocity by an average of 1.65 km/hr over 119m, indicating a greater increase in wind velocity when there the contrast of temperature between the heated area and the overall area is more distinguished. In analyzing wind trends based on local orography, the knowledge gained will be significant in designing future buildings and cities for generating wind flow that maximizes the release of heat and usage of natural energy.

165. PRODUCING ELECTRIC POWER FROM WIND ENERGY USING DIFFERENT BLADES

Eleanor O. Frost. Chaminade College Prepatory, West Hills, CA.

The use of wind as an energy source dates back centuries, but interest in wind energy as an alternative soared in the 1970's with the first oil shortage. Today, electricity generated from the wind can help our society become less dependent upon the production of foreign oil. Windmills of old were made with blades that had a cross-section of a rectangle. These were inexpensive blades sweeping out small circles by today's

standards. Blades today have airfoil cross-sections. Airfoils reduce drag and increase the performance of the blade. My hypothesis is that the rounded airfoils will outperform the others, including the control blade due to less drag and lift of the rounded blades. To test my hypothesis, I created a wind tunnel and wind mill to test the different blades. The blades were readily available from Flying Foam, Austin Texas, in both 2 and 3 inches from front to back. The length of the blade was 15 inches. The windmill was made out of PVC pipe, inspired by a 2009 US Department of Energy Report. To smooth the airflow, I used an array of pre-cut pipes resembling the same in that same 2009 US DOE report. In each series of experiments, I waited for the wind tunnel and air smoother to reach a steady state flow of air. The airflow had three speeds: 3.4 m/sec, 3.0 m/sec, and 2.1 m/sec. I set the angle of the blade and then put the windmill into the airflow. I waited for the rotors to reach steady state and then took measurements of volts and amps. I averaged the observations, multiplied volts times amps and graphed the results. My hypothesis was not correct as the flat bottomed airfoils outperformed the rounded airfoils both when compared with each other and the control blade. Moreover, the flat airfoils produced the largest percentage electrical output when compared to the Betz Theoretical Maximum Limit of Power Available. The largest output occurred with blades at 5 to 10 degree angle to the wind and these test generally required more time for the blades to reach a steady state rotational velocity. The observations suggest that the static angle of attack measured is different to the angle of attack the blade experiences during rotation. The vector due to the rotation of the blade when added to the vector from the wind tunnel, add to create a new angle of attack for the blade in the wind.

166. INVESTIGATING THE POSSIBILITY OF VENOM WITHIN THE SPECIES OF SCORPIONFISHES AND SCULPINS

R.L. Sanders. Culver City H.S.; Mentor, Dr. Alioto-Juradop, U.C.L.A.

The occurrence of venomous species has been well documented within taxonomic groups such as reptiles, arachnids, and insects. However the distribution of venomous species within bony fish is not well studied. Some species with medically relevant venom within their spines include the lionfish, stonefish, and toadfish. In this study I will collect several species of *Sculpin* and *Scorpion fishes* and I will dissect them in order to determine if they produce any venom or not. The species that are collected must have a hard bony spine or similar suitable venom delivery apparatus in order to be a candidate for being venomous. If a fish cannot penetrate its target to inject venom it will be unable to deliver injected venom into it and therefore cannot be described as venomous even if its body produces a chemical toxin. Fish possessing a suitable venom delivery apparatus will have their whole venom apparatus extracted. Histological preparations will be made of the tissue and possible venom proteins will be isolated. We will place the proteins into a detergent, which will denature them in a manner, which stretches the molecules out from beginning to end. Finally, once the proteins are stretched out, we will be utilizing the SDS-PAGE, which will separate the molecules according to their size. From there we will determine whether or not these fish are venomous or not.

167. WHOLE FOOD DIET AND AEROBIC EXERCISE EFFECTS AGE DEPENDENT COGNITIVE DECLINE

Diep, Charlie[1], Amelia Russo-Neustatd[2], and Ross Gibson[3]. [1]San Gabriel High School; [2]School of Natural & Social Sciences MD, Ph.D. Department of Biological Sciences. Cal State LA; [3]Department of Biological Sciences. Cal State LA.

We are looking for a shift in mental health due to age and diet in rats and how it can be compared to humans when they age. We use the Sprague Dawley strain from the Rattus Norvegius. Behavior and intelligence in test rats were analyzed using the Barnes Maze test and object recognition, while having ashwagandha, a supplemental anti-stress factor, as the main factor in the study. The groups include: a running group, a control group, a W.S. group that received ashwagandha, the whole food group, and a combined treatment group that received all three interventions: running, ashwagandha, and the whole foods. Rats are monitored and tested throughout their lifespan to attempt to slow down their depreciation of mental health. With the object recognition test, the data shows there was not a big significant change in the ratio of time spent looking at the objects when comparing the morning testing to the evening testing.

168. ANALYZING THE ABUNDANCE OF THE PYRUVATE KINASE ENZYME AND CITRATE SYNTHASE ENZYME IN THE GLUCOSE METABOLIC PATHWAYS OF BREAST CANCER

Bernadette Lim and Dr. Emily Wang. St. Lucy's Priory High School; West Sierra Madre Ave. Glendora, CA 91741 Beckman Research Institute of City of Hope, Division of Tumor Cell Biology, KCRB Room 2007; 1500 East Duarte Rd. Duarte, CA 91010.

A study of the activity of mainly the pyruvate kinase enzyme (PKM) and citrate synthase enzyme (CS) in breast cancer pathways was analyzed through quantitative and analytical analyses that included results deduced from quantitative real time polymerase chain reaction, protein immunoblots, and assays that recorded the activity of the pyruvate kinase enzyme. Three experimental variable cell lines derived from the MDA-231 human breast cancer cell line were used in this study for comparison. These variables are associated as parental (P), with no specific metastatic potential; highly metastatic (HM), as the name suggests; and brain (BR), with metastasis specific to the brain.

Results indicated from the quantitative real time polymerase chain reaction experiments show that the more metastatic cell lines, HM and BR, have a higher quantity and presence of the citrate synthase enzyme than that of the pyruvate kinase enzyme. Of the cell lines, HM has a most evident increase in quantity and presence of citrate synthase than that of the pyruvate kinase enzyme. The P cell line, with no specific metastatic potential, displayed equal quantities of PKM and CS. These results are further supported by corollary data from the pyruvate kinase activity assay, which indicated the P cell line experienced the highest PKM activity amongst the three cell lines and the HM cell line experienced the lowest PKM activity. Imaging from the protein immunoblot assay also supports this claim in that the presence of PKM in the HM cell line was significantly lower and less visible than its presence in the P and Br cell lines, while PKM had its strongest presence in the P cell line.

From these assessments, it can be concluded that relationship between the activity and presence of the PKM and CS enzymes for the HM and BR cell lines is inversely related. It can also be concluded that the metastatic cell line, HM, has greater CS activity and thus a greater affinity to catalyze the formation of the citrate molecule in the citric acid cycle. This can also be concluded, though to a lesser extent, of the BR cell line. Further research with these cell lines could help in the argument of the legitimacy of the Warburg effect in cancer metastasis.

169. LINKING T-RFLP AND CLONE LIBRARIES IN THE INVESTIGATION OF BACTERIA FROM DEEP METHANE SEEPS

Grace Vasiknanonte[1] and Mentor: Dr. Joshua Steele[2]. [1]Bishop Alemany High School; [2]California Institute of Science and Technology.

Microbial communities are incredibly diverse but fully understanding them has been difficult due to limitations of culturing cells in the laboratory. Terminal restriction fragment length polymorphism (T-RFLP) is a powerful tool that can be used to analyze members in a microbial community by identifying similarities according to gene fragment lengths. In this experiment, 16S rRNA genes from a bacterial community in a deep methane seep off the coast of Oregon were taken from previously prepared clone libraries. The samples, unique members of their community, were amplified using PCR with M13 forward and M13 reverse primers. During the reconditioning process, samples were fluorescently labeled using bacterial specific D3 16S 27 forward and D4 universal 16S 1492 reverse primers. After digestion with the Hae III restriction enzyme, samples were run on a sequencer that analyzed the length of the fragments in base pairs. From there, the data was compared to the predicted and actual fragment lengths of these samples. At least twenty-six DNA samples were analyzed with results that identify bacteria such as Desulfosarcina (a sulfate reducer) and Firmicutes. These results substantiate previous experiments and build upon the existing database to allow for comparison across samples.

170. WIRELESS ENERGY TRANSFER

Cameron Yang[1] and Mentor: Professor David Cheng[2]. [1]Troy High School; [2]Electrical Engineering Department Cal State Fullerton.

Imagine a future without wires. Cars and planes could run indefinitely without stopping and without using gas or fuel. Issues concerning oil would be over. Although those possibilities are farther away, that is the goal for wireless energy. The transfer of wireless energy is through the method of electromagnetic induction, which is the concept of transferring energy by creating a magnetic field. The copper wires are surged with an electric current, which is what generates the magnetic field. The issue with this is the traditional method of induction is bulky for transporting energy even across a couple feet. Commercializing this technology by making it more compact is a problem that I, among other scientists, am trying to solve.

At first, I tried to solve this problem by creating a magnetic field, in an attempt to boost the signal, but nothing happened. Afterwards, I then realized the issue was not only the strength of the signal, but also the surface area of the receiver. Upon discovering this crucial fact, I then attempted to use different shapes to increase the surface area of the receiver. It is important to note that all results gathered from these different shape trials were compared against the standard circle shape. The shape I started with was a square inside a circle. I ran many trials, recording each distance from each trial. I then repeated this with a triangle inside a circle, and a circle within a circle. The results from these experiments unfortunately did not return a positive result. The distances recorded from each did not differ enough from the control's distance to be considered positive.

From my experiments, I can say that the future without wires is still a far ways off. However, my research was not by all means exhaustive and other methods can be explored. For example, a method of transferring energy through a combination of microwaves and induction can be explored. Furthermore, perhaps superconductors could be used to garner more energy which could lead to increased distance. Ultimately, the search for a future without wires is still a future, for now.

171. INVESTIGATION INTO ACCURATE CAPACITANCE MEASUREMENTS AND THE EXTENT OF CAPACITORS BEING A NEW ENERGY SOURCE

William Ton[1] and Mentor: Oscar Bernal[2]. [1]Alhambra High School, Los Angeles, CA, 91801.; [2]Nuclear Magnetic Resonance/Experimental Physics Condensed Matter Research Group, California State University Los Angeles, Department of Physics and Astronomy, Los Angeles.

Capacitors are used to store energy from direct current and convert it to alternating current. The ability of capacitors can be used as a new power source. This ability of a capacitor to act as a new power source is limited by the uncertainty of its capacitance. This experiment was designed to determine and understand the factors that impede accurate capacitance measurements to the manufacturer's value and the extent of capacitors being a new power source. The circuits in the experiment were designed using the AC voltage divider method: connecting a resistor to a capacitor and hooking it to a Function Frequency Generator. A multimeter was used to measure the circuit's voltages and the capacitance was calculated from these values as well as its charge, beginning with an unshielded 2,200 millifarad (μf) capacitor and 20 ohms resistor at the ranges of 1–50 Kilohertz (KHz). The capacitance was closest to the manufacturer's value up to 3 Kilohertz but deviated at higher frequencies.. The most accurate ranges of the 2,200 millifarad capacitor at 1–3 Kilohertz were then applied to a shielded 10 microfarad capacitor circuit. However, the new measurements were a factor of one off from the manufacturer's value at low frequencies and worse at higher ones. The data taken shows interference from electromagnetic fields within the circuit may have caused fluctuations in the measurements of the shielded 10 microfarad circuit while the 2,200 millifarad circuit measurements showed some correlation to the manufacturer's value.

172. FACES IN MOTION: A STIMULUS SET FOR EVALUATING THE RELATIVE EFFECTS OF MOTION AND FACES ON OVERT VISUAL ATTENTION

Ryan Hyon. Polytechnic School; Mentor: Dr. Blythe Towal.

Autism spectrum disorder (ASD) is a complex disorder of brain development in which autistic subjects are affected by impaired social interaction and communication skills. It has been observed that normal subjects tend to rapidly focus on facial regions when looking at images containing human faces. Is this the same case in dynamic scenes that may contain other inanimate objects as well? What are the differences between adults with ASD and typical adults with respect to their eye movement patterns? How similar are the durations of time that autistic and normal subjects spend fixating on faces? We created a large database of videos of both

staged and natural scenes that contain stationary or moving humans and objects. These videos, fit with specific criteria, will serve as the stimuli for both normal and autistic subjects while their scan paths are identified by an eye-scanning device. We also created a fixation-identification algorithm that simplifies a list of point-of-regard data into a more convenient set of data to be further analyzed. We plan on publishing our database of video stimuli, and we plan to determine the answers to the abovementioned questions after adjusting the parameters of our algorithm and obtaining sufficient data for analysis.

173. QUADROCOPTER AERIAL MONOCULAR VISION FOR IMPROVED AUTONOMOUS ROBOT NAVIGATION

Kenny Lei. Walnut High School, 400 N. Pierre Road, Walnut, CA 91789. Harvey Mudd College, 301 Platt Boulevard, Claremont, CA 91711.

Conventional ground robot navigation and path finding is often inefficient and time-consuming, especially in a maze-like environment. Aerial vision, however, provides a novel perspective in finding the path finding for robot navigation. Aerial vision in combination with ground robot was compared to solely ground robot navigation for operational time.

A ground robotics platform was based off an iRobot Create and laptop. Aerial vision was achieved through the Parrot AR.Drone quadrocopter with a built-in camera. A laptop was connected to the camera feed of the quadrocopter via socket connections to its wireless network. Java programming language was used for both quadrocopter control and image processing. The quadrocopter was initiated and hovered above the robot and maze environment. Images acquired were initially processed to classify regions as either obstacle or traversable area. Start and end point regions were then classified within the image. A breadth first search (BFS) algorithm was employed to determine the shortest navigational path that avoids obstacles. When a traversable path between the detected start and end points is found, the ground robot is sent movement vector commands to navigate around the obstacles.

After a series of trial runs, the novel navigation yielded an average run time of 38.45 seconds while the conventional navigation resulted in an average run time of 140.57 seconds. The addition of aerial vision from the quadrocopter resulted in a 72.6 percent improvement in operation time for the ground robot. These findings demonstrate rich data provided from aerial imagery significantly enhances and improves robot navigation.

174. BOBBING BRUSHES: COLLECTING LARVAE OUT IN THE PACIFIC

J.E. Steers and **K. Remmes**. Larval Settlement Laboratory, Ocean Institute, Department of Husbandry, Dana Point, CA 92629.

The Ocean Institute lives by the following creed: Experience is the Teacher. Our latest endeavor has developed many partnerships and implemented a unique hands-on experience. The Nicholas Endowment has provided the Ocean Institute with the opportunity to create our Larval Settlement Laboratory. Interns and staff use our petite lab to focus on the youngest life stages of marine organisms, including settlement and recruitment dynamics.

Currently, we are analyzing larval settlement at the largest artificial reef in the United States. The reef, coined Wheeler North Reef, was completed in 2008. It was built just off San Clemente to mitigate any impact on marine life from the San Onofre Nuclear Generating Station (SONGS). SONGS requires the ocean's water to cool its system so when the water exits back into the ocean, it is warmer and raises the temperature of the ocean around the plant. This increase in temperature affects the normal and natural growth of kelp; thus, the need for an artificial reef.

The reef is already home to many species and, hopefully, hundreds more as it develops. Our team is conducting research with senior scientists at UC Santa Barbara by deploying brushes within the reef to see what organisms settle.

175. USING TERRESTRIAL INVERTEBRATE SURVEYS TO ASSESS PRODUCTIVITY IN THE BALLONA WETLANDS ECOLOGICAL RESERVE

Matthew Waterworth. Loyola Marymount University, Department of Civil Engineering and Environmental Science, Los Angeles, CA, 90045.

The Ballona Wetlands Ecological Reserve (BWER) in Los Angeles, CA has been negatively affected by anthropogenic forces, which have been previously shown to cause a decline in the native vegetation and terrestrial vertebrate populations. The goal of this study was to determine the taxon distribution of terrestrial invertebrate species within the Ballona Wetlands. Previously, the Baseline Assessment Program at the BWER conducted aerial terrestrial invertebrate surveys to extrapolate aerial arthropod productivity (as biomass) using length-fresh weight regressions for each habitat. In the second year of the Baseline Assessment Program, pitfall invertebrate surveys were added to improve the understanding of the invertebrate productivity, distribution, and presence in different habitats. Pitfall traps were deployed along transects located in the different habitats present on the BWER (CDFG 2007). Each invertebrate caught was counted, measured, and identified to the lowest feasible taxon. By analyzing the specimens caught between the 2010 and 2011 sampling period, we hope to determine the distribution and relative abundance of invertebrate populations by transect and habitat type in the wetlands. This baseline information will be used in future studies in order to see potential changes in the distribution or productivity of terrestrial invertebrate populations within the wetlands, possibly showing differences between habitat types or vegetation alliances.

176. AN UNLEVEL PLAYING FIELD: ASSESSING VEGETATION AND ELEVATION

E. Del Giudice-Tuttle, I. Medel, C. Piechowski, and K. Johnston. Santa Monica Bay Restoration Commission, Los Angeles, CA 90045.

Over the past century, the hydrology, geomorphology, and connectivity of the Ballona Wetlands Ecological Reserve (BWER) have been altered, resulting in extensive habitat modifications and degradation of the wetlands. Non-native plant species are present throughout the Ballona Wetlands Ecological Reserve (BWER); these non-native species are indicators of past disturbances to the wetland and have potentially reduced the value of the site as habitat for native plants and native wildlife.

The goal of this project was to assess the following hypotheses: 1) there is a significant difference in the nativity and vegetation composition between habitat types; 2) there is a significant difference in elevation between habitat types; and 3) a correlation exists between elevation and vegetation within habitats.

All three hypotheses were found to be true based on statistical analyses of data collected in the first year of sampling at the BWER. While elevation within a marsh system is not the single defining factor determining vegetation distribution, it was found to be significant in this system. This is likely due to the input of dredge spoils and subsequent increase in marsh plain elevation over much of the site. Additional physical and biological attributes will continue to be assessed in relation to vegetation cover. The ability to quantitatively confirm vegetation nativity habitat characteristics is important for the future of the restoration project and will influence the management and restoration of the site.

INSTRUCTIONS FOR AUTHORS

The BULLETIN is published three times each year (April, August, and December) and includes articles in English in any field of science with **an emphasis on the southern California area**. Manuscripts submitted for publication should contain results of original research, embrace sound principles of scientific investigation, and present data in a clear and concise manner. The current AIBS *Style Manual for Biological Journals* is recommended as a guide for contributors. Consult also recent issues of the BULLETIN. Manuscript preparation guidelines are at SCASBULLETIN.ORG.

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An abstract summarizing in concise terms the methods, findings, and implications discussed in the paper *must* accompany a *feature article. Abstract should not exceed 100 words.*

A feature article comprises approximately five to thirty typewritten pages. Papers should usually be divided into the following sections: abstract, introduction, methods, results, discussion and conclusions, acknowledgments, literature cited, tables, figure legend page, and figures. Avoid using more than two levels of subheadings.

A research note is usually one to six typewritten pages and rarely utilizes subheadings. Consult a recent issue of the BULLETIN for the format of *notes*. Abstracts are not used for notes.

Abbreviations: Use of abbreviations and symbols can be determined by inspection of a recent issue of the BULLETIN. **Omit periods after standard abbreviations:** 1.2 mm, 2 km, 30 cm, but Figs. 1–2. Use numerals *before* units of measurements: 5 ml, but nine spines (10 or numbers above, such as 13 spines). The metric system of weights and measurements should be used wherever possible.

Taxonomic procedures: Authors are advised to adhere to the taxonomic procedures as outlined in the International Code of Botanical Nomenclature (Lawjouw et al. 1956), the International Code of Nomenclature of Bacteria and Viruses (Buchanan et al. 1958), and the International Code of Zoological Nomenclature (Ride et al. 1985). Special attention should be given to the description of new taxa, designation of holotype, etc. Reference to new taxa in titles and abstracts should be avoided.

The literature cited: Entries for books and articles should take these forms.

McWilliams, K. L. 1970. Insect mimicry. Academic Press, vii+326 pp.

Holmes, T. Jr., and S. Speak.1971.Reproductive biology of Myotis lucifugus. J. Mamm., 54:452–458.

Brattstrom, B. H.1969.The Condor in California. Pp. 369–382 in Vertebrates of California. (S. E. Payne, ed.), Univ. California Press, xii+635 pp.

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Cover: A near maximum size (7 ft; 500 pound) giant sea bass (*Stereolepis gigas*) captured by an anonymous commercial fisherman (pictured) in January 2010 off Santa Cruz Island and legally landed at the wharf in Santa Barbara (photo courtesy of Jeffrey Cecilia, Santa Barbara Fish Market).